

COASTAL OCEAN MODELING
GORDON RESEARCH CONFERENCE
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COLBY-SAWYER COLLEGE
NEW LONDON, NH, USA

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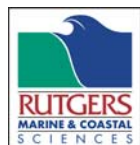
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Report Documentation Page				Form Approved OMB No. 0704-0188	
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Nitrogen and carbon cycle modeling of the Northeast North American shelf: Nesting ROMS within HYCOM

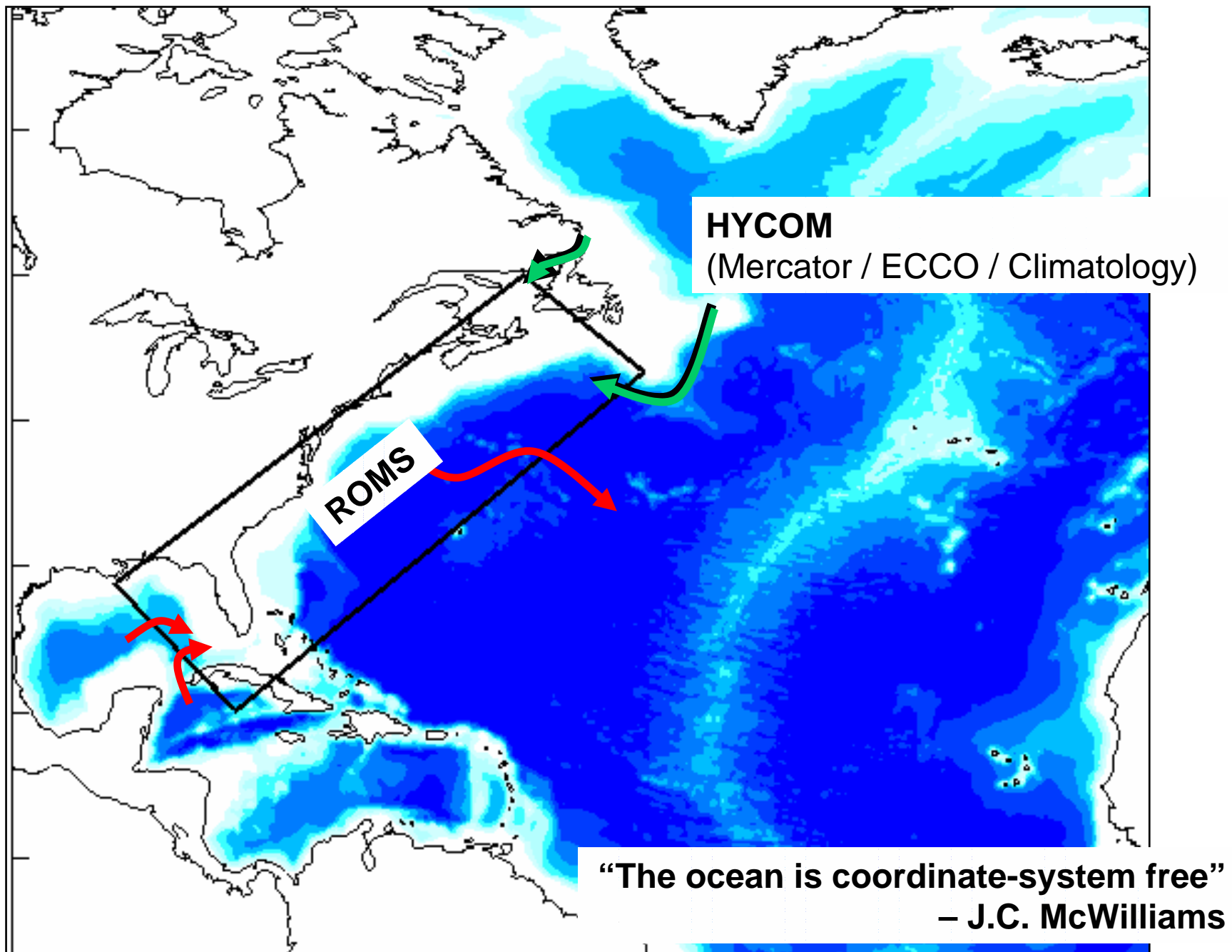
John Wilkin

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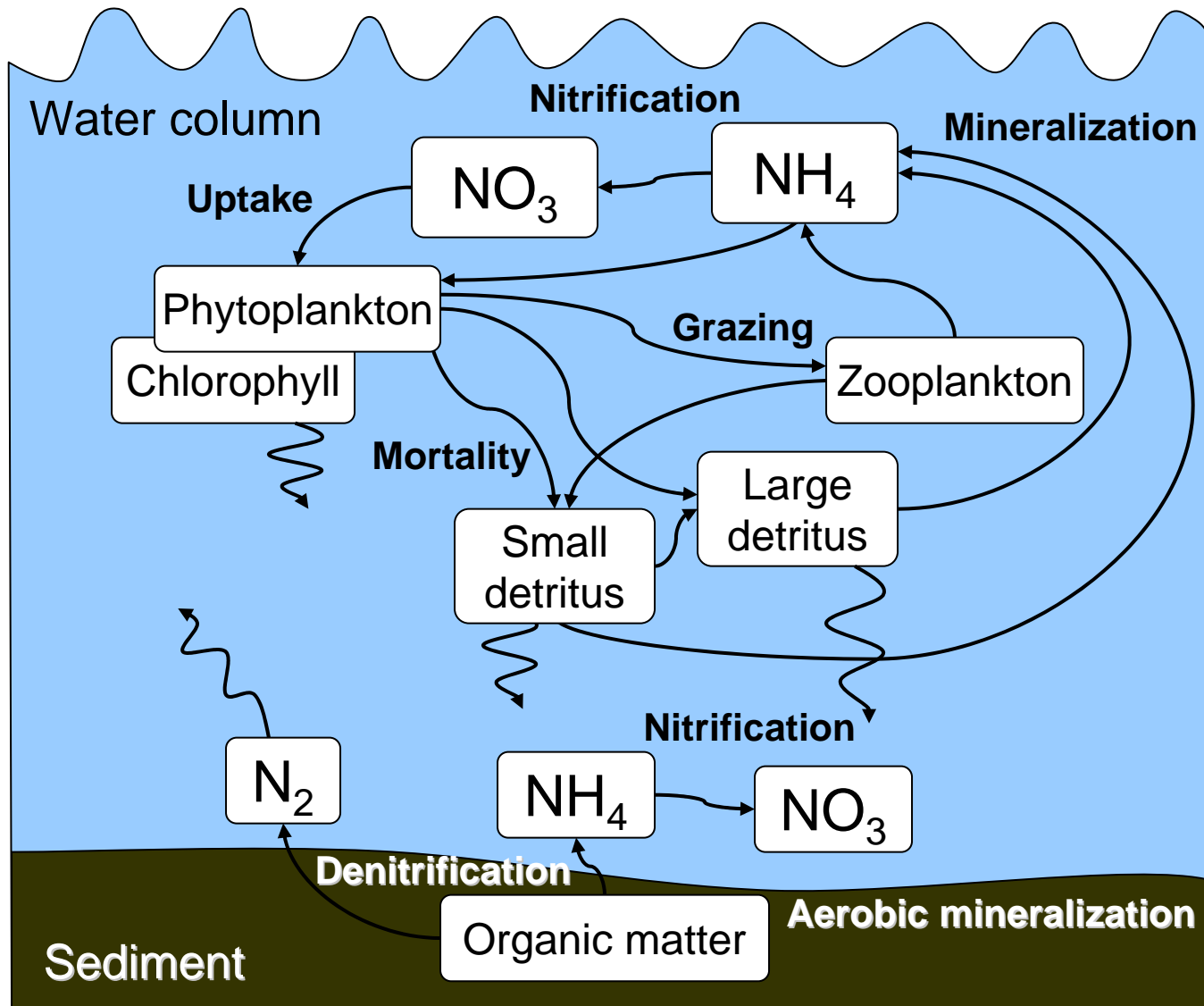


jwilkin@rutgers.edu

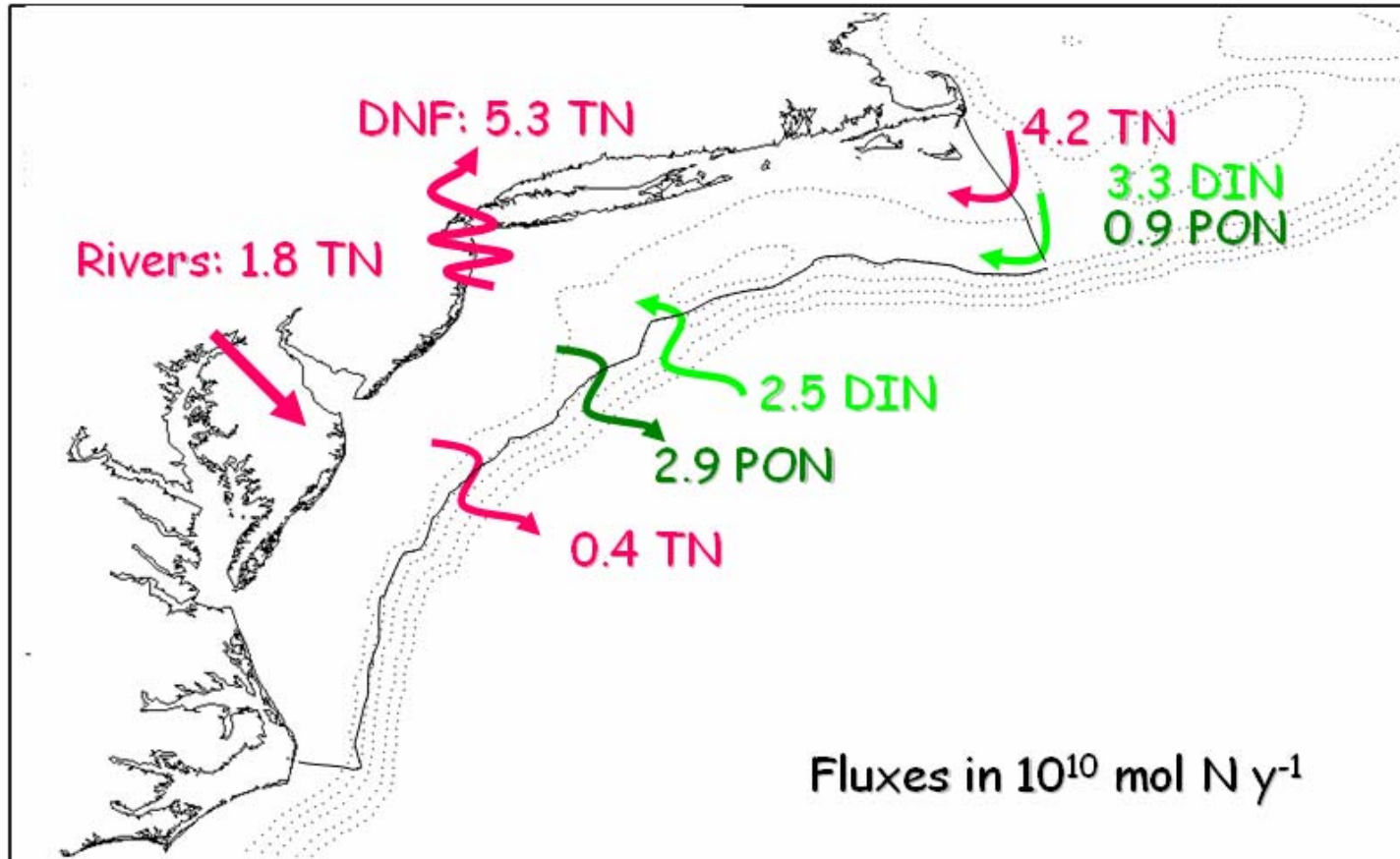
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Circulation and biogeochemical modeling

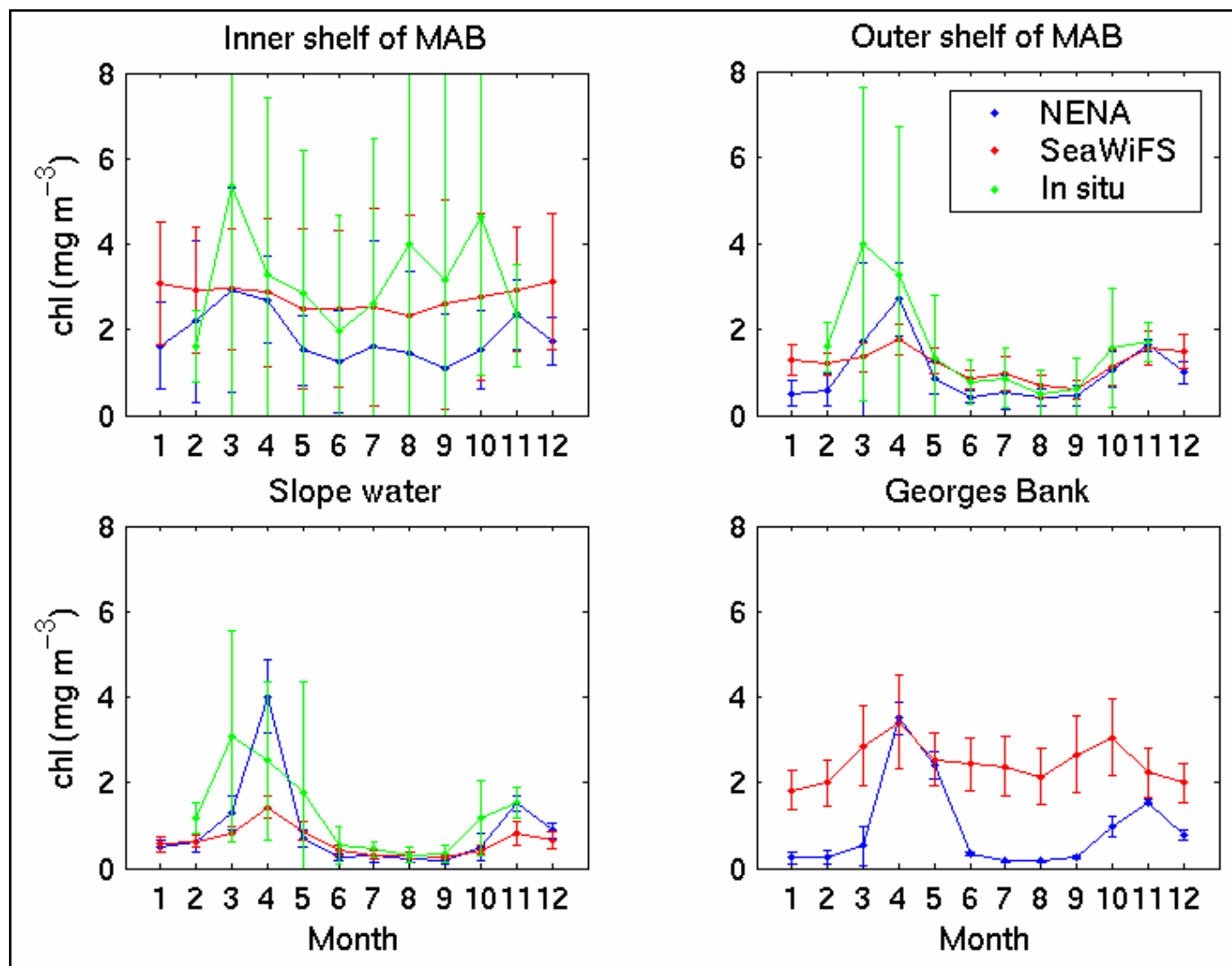


Nitrogen cycle modeling for wide shelves



**Sources and
sinks of
nitrogen**

Role of shelf
denitrification



**Model-data
comparisons**

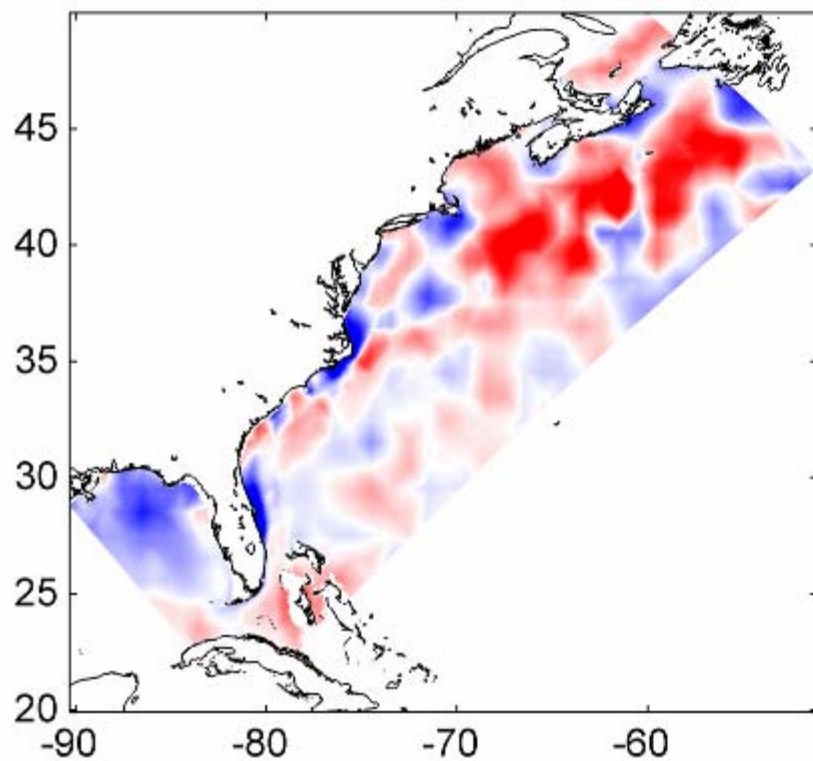
**← Model
crashes in
summer
(no tides)**

Fennel, Wilkin,
O'Reilly

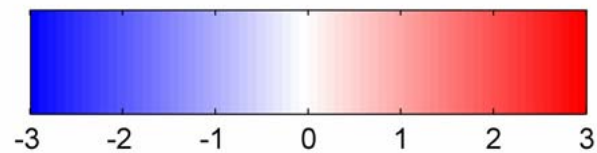
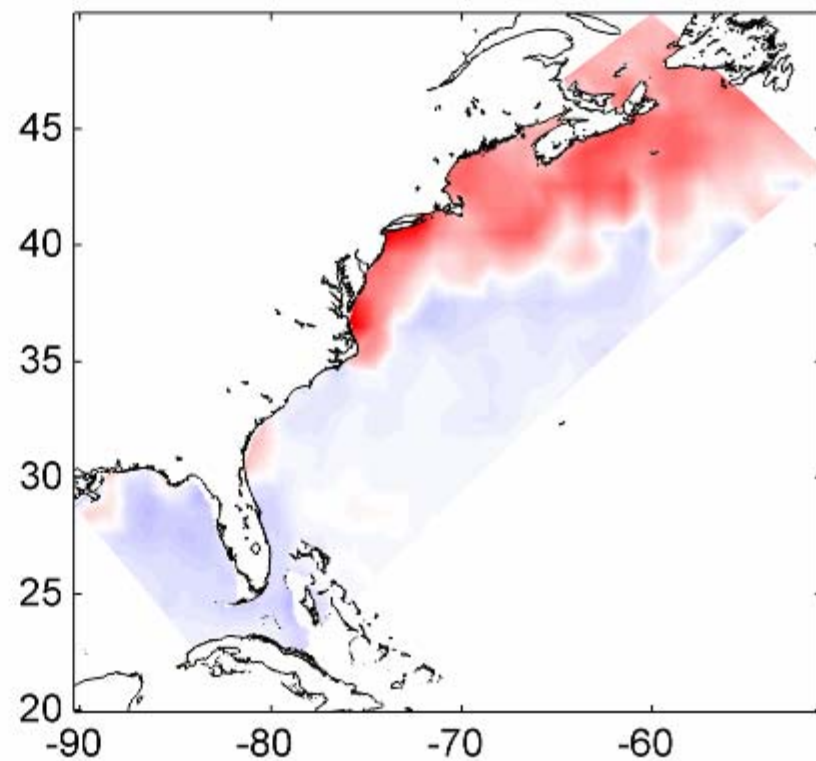
ROMS in Hycom NENA configuration

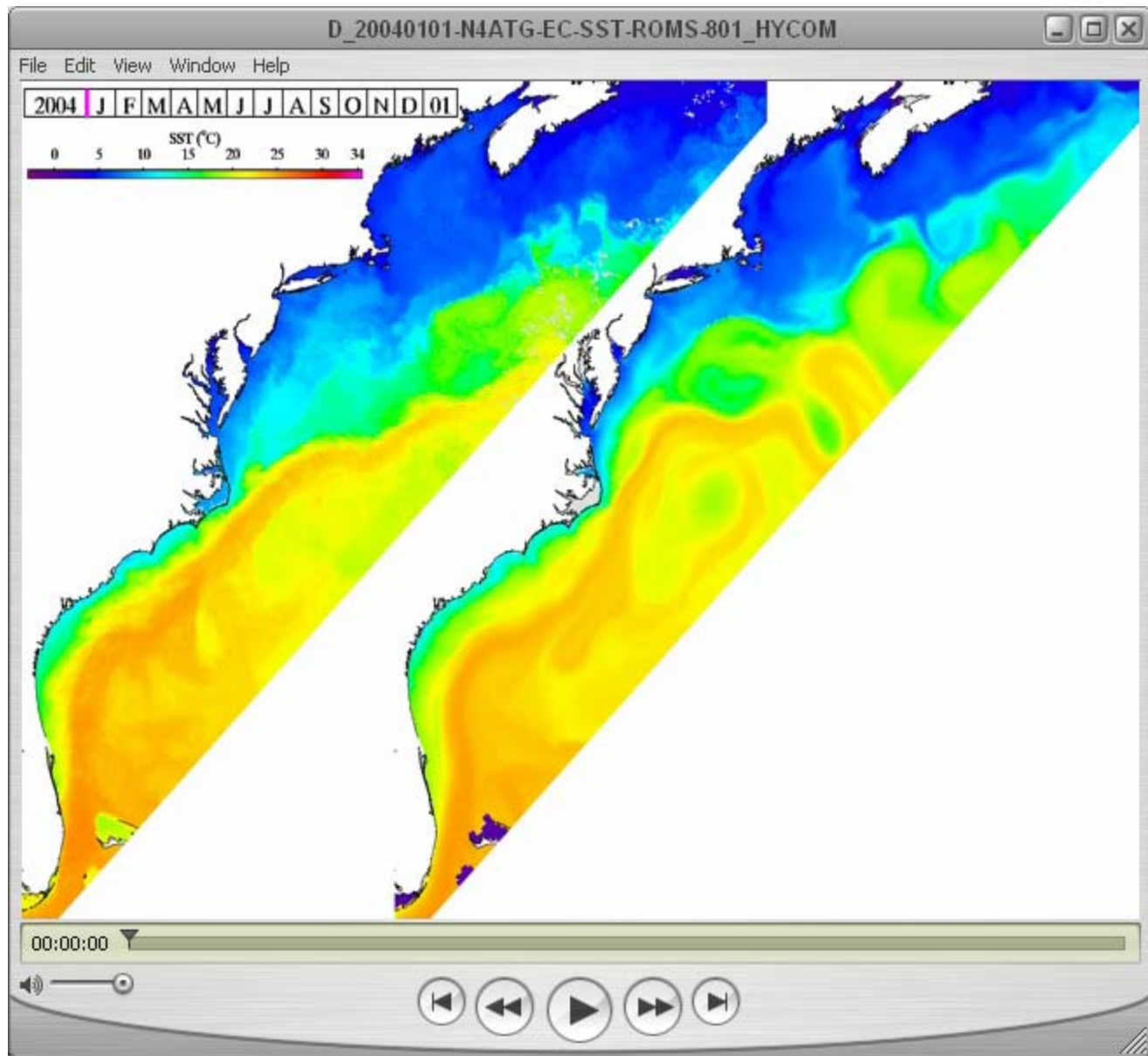
- 10 km horizontal, 30 s-levels terrain-following
- NCEP daily surface atmospheric reanalysis
 - *Fairall et al. 2003 bulk flux air-sea exchange parameterization*
 - *daily shortwave modulated for diurnal cycle*
 - *evaporation from latent heat minus NCEP precip*
- embedded in Hycom North Atlantic best-estimate daily
 - *Hycom T,S bias w.r.t. Hydrobase annual mean is removed*
 - *radiation/nudging to Hbase+Hycom' T,S and \mathbf{u} at perimeter*
 - *200 km linear taper nudging region 0 to 2 day⁻¹ at perimeter*
 - *OTPS/TPX03 tides and Flather condition with Hycom ζ , \bar{u}*
- Monthly climatological rivers (Seitzinger)
- Mellor-Yamada 2½ vertical turbulence closure
- Start physics in June 2003
 - *start BGC in January 2004*
 - *BGC boundary conditions from regressions of tracer on T,S data*

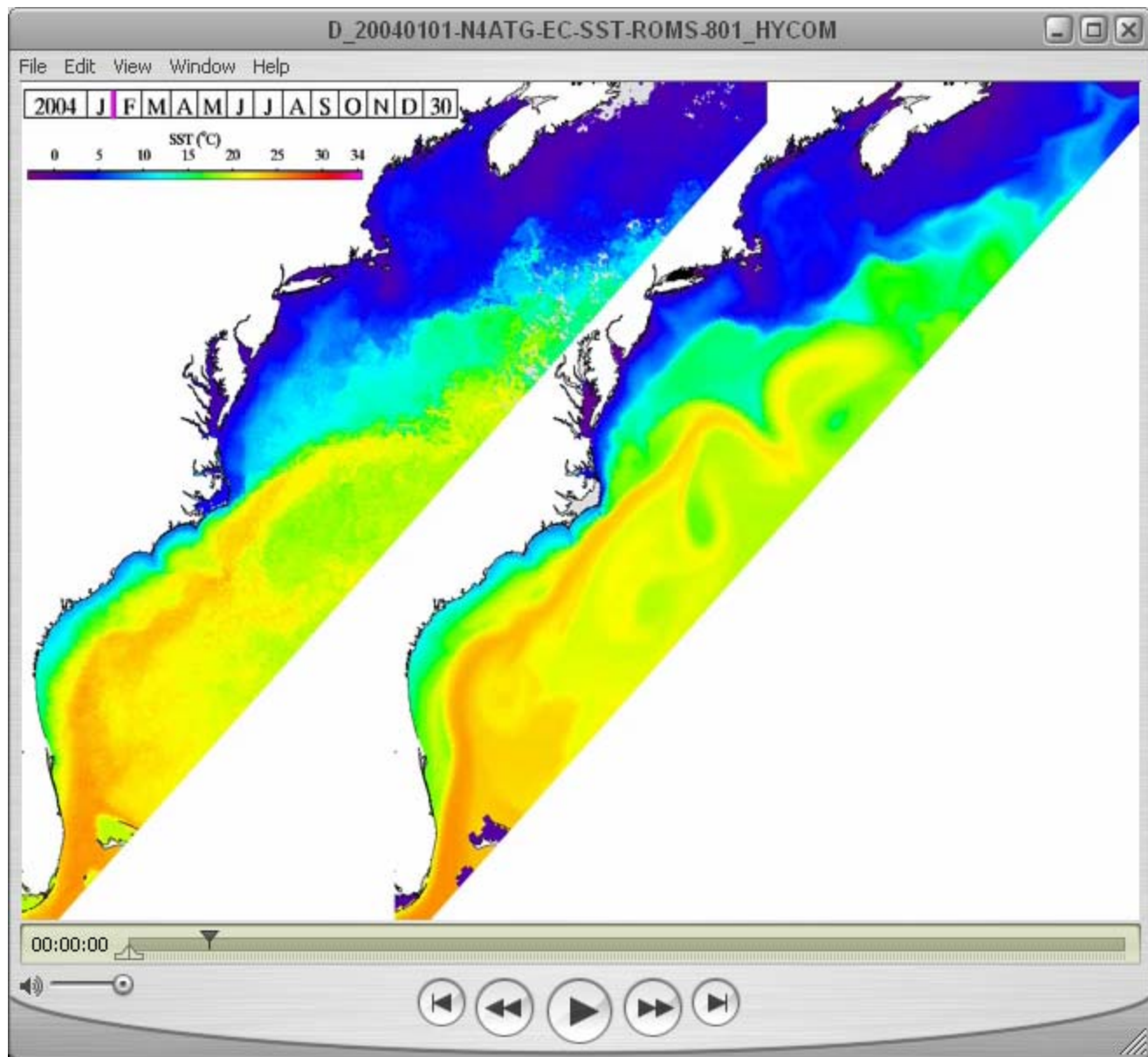
Temperature at 10 m Hycom-Hydrobase

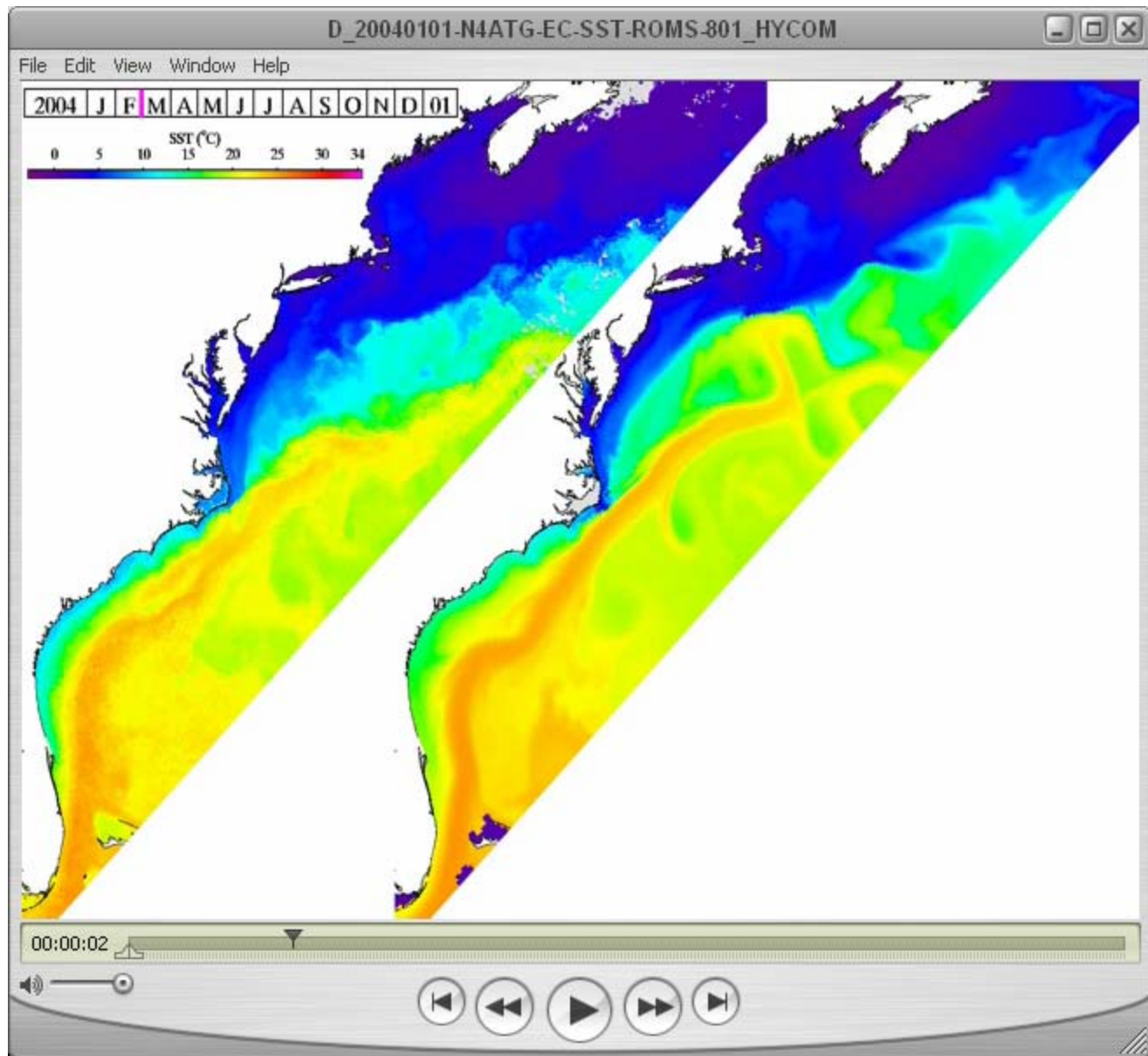


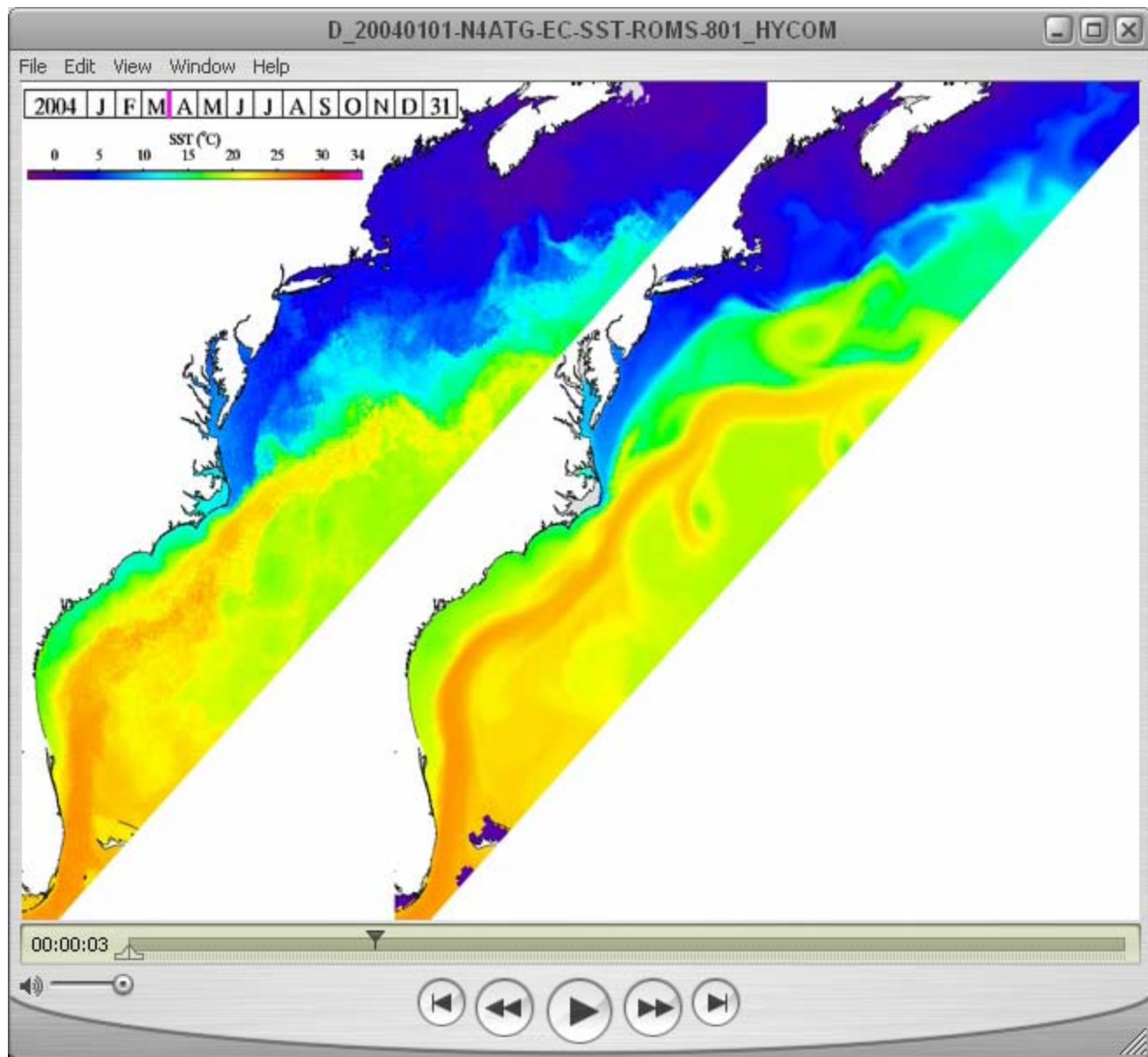
Salinity at 10 m Hycom-Hydrobase

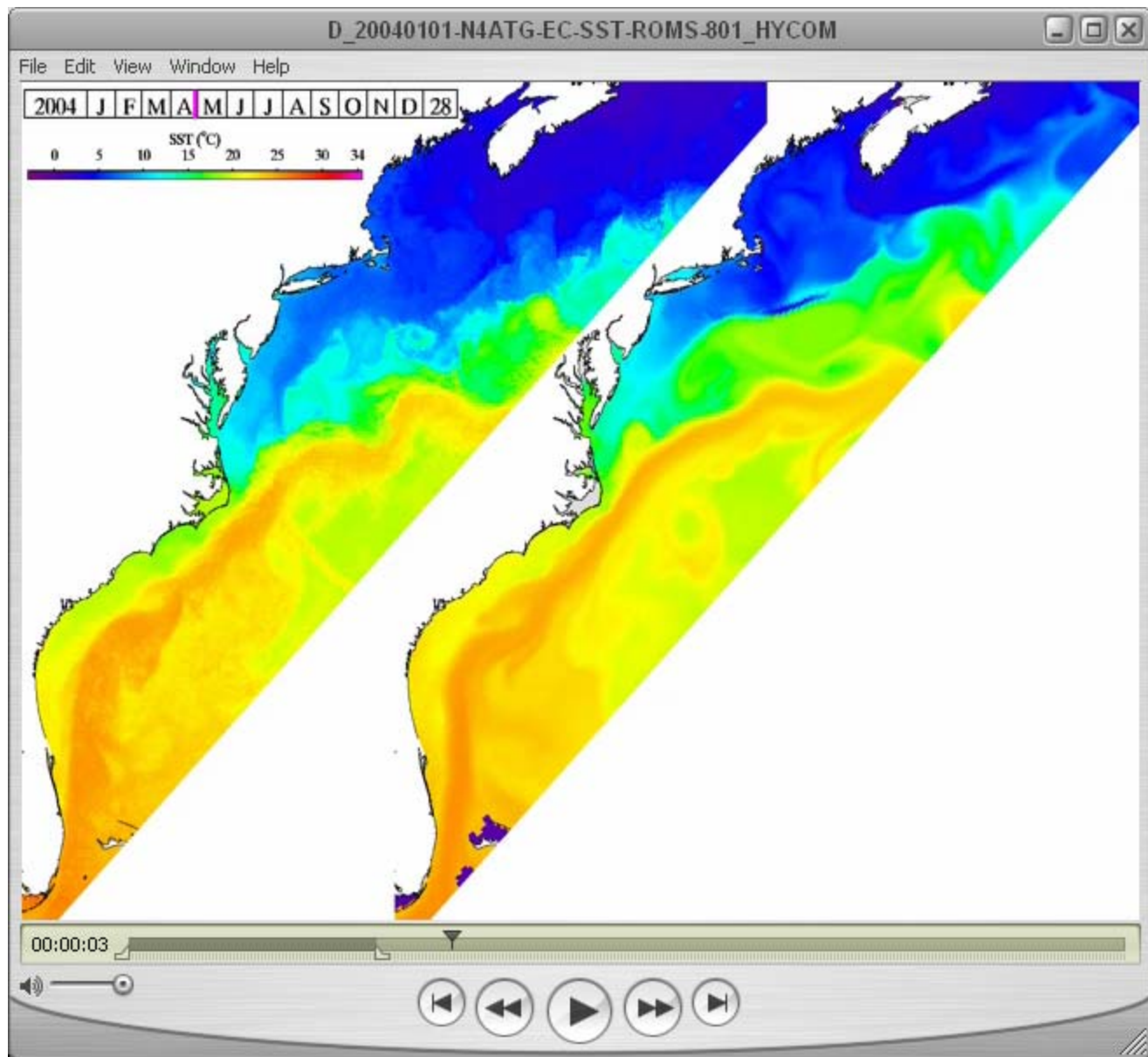


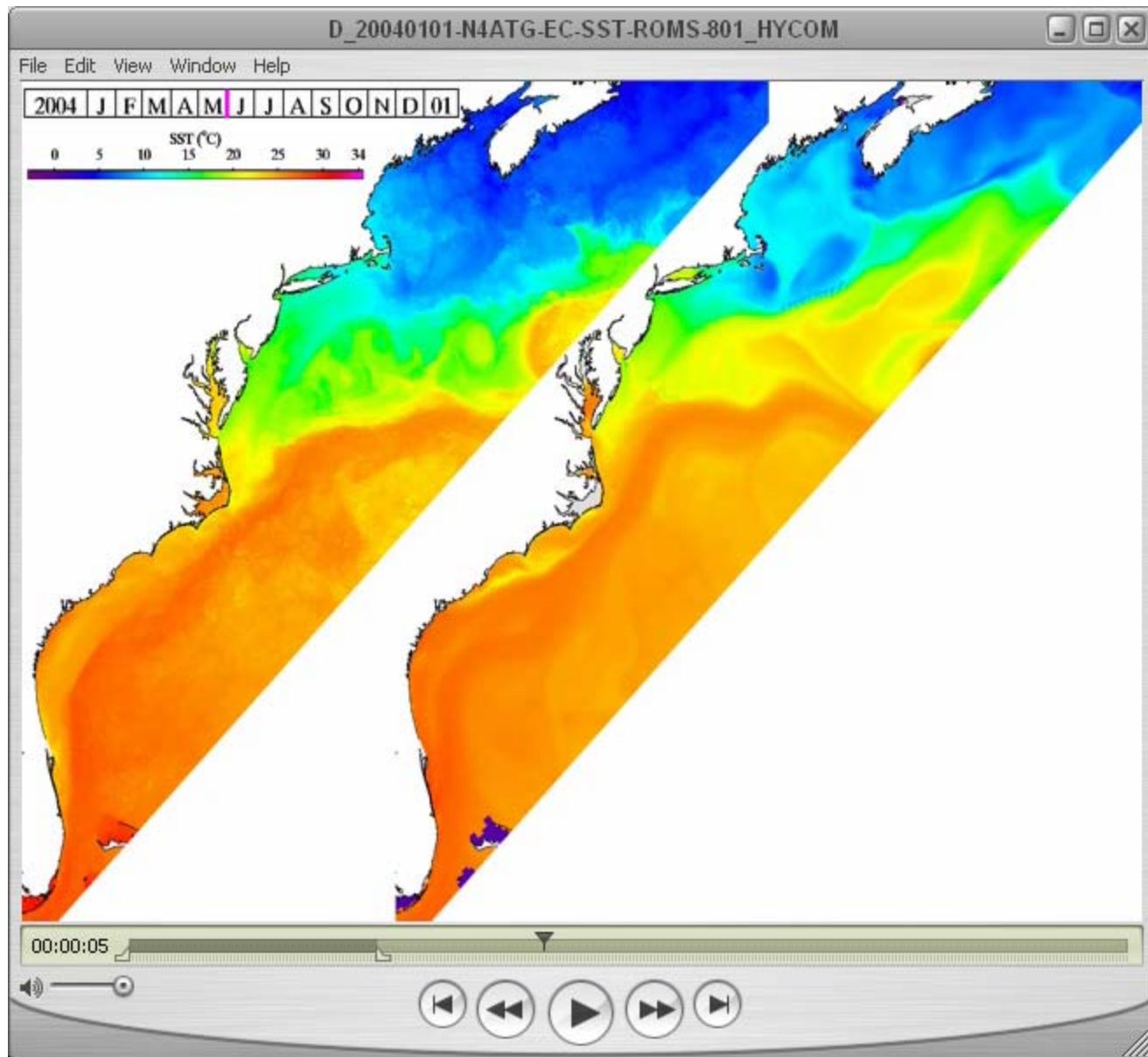


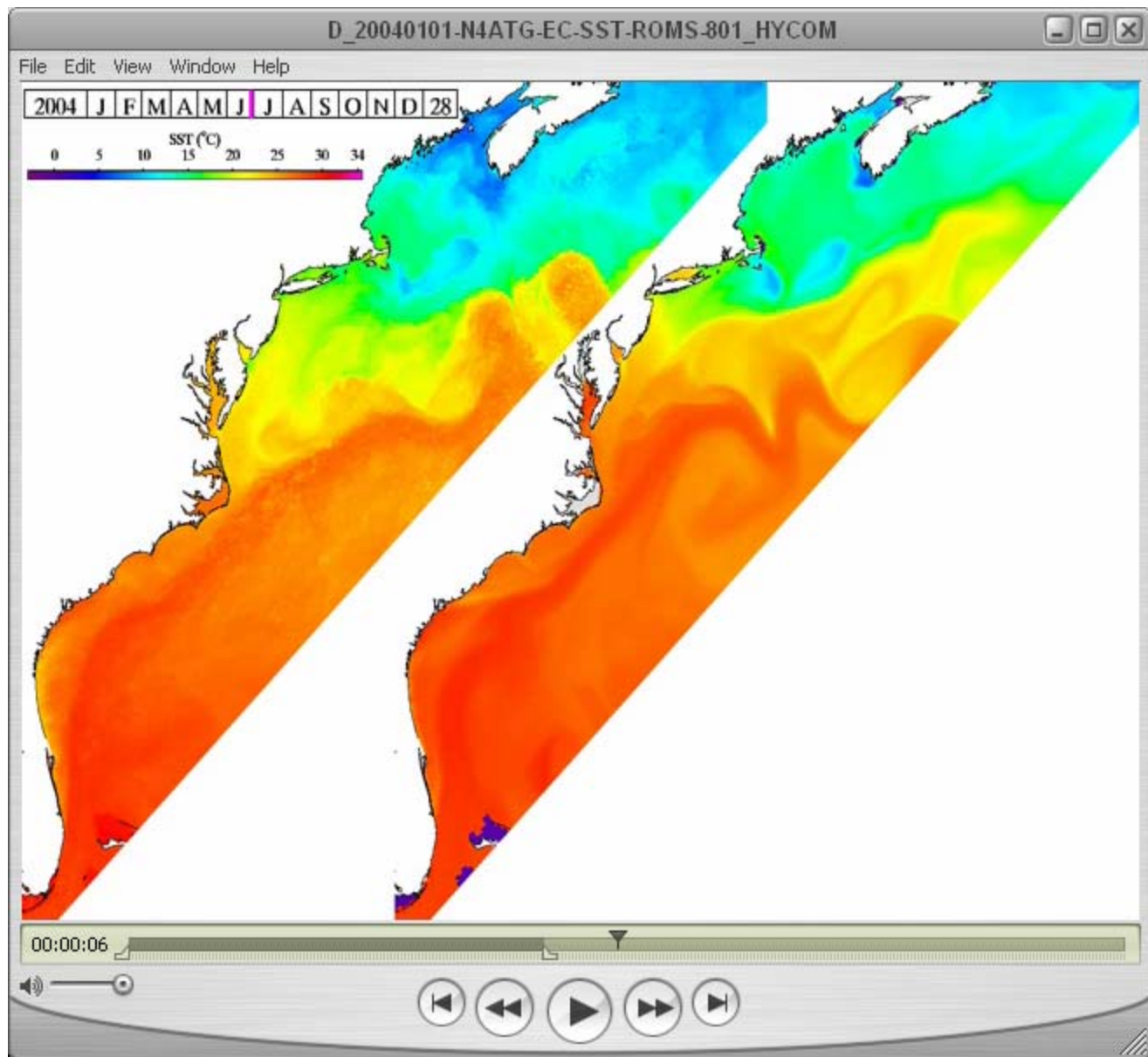


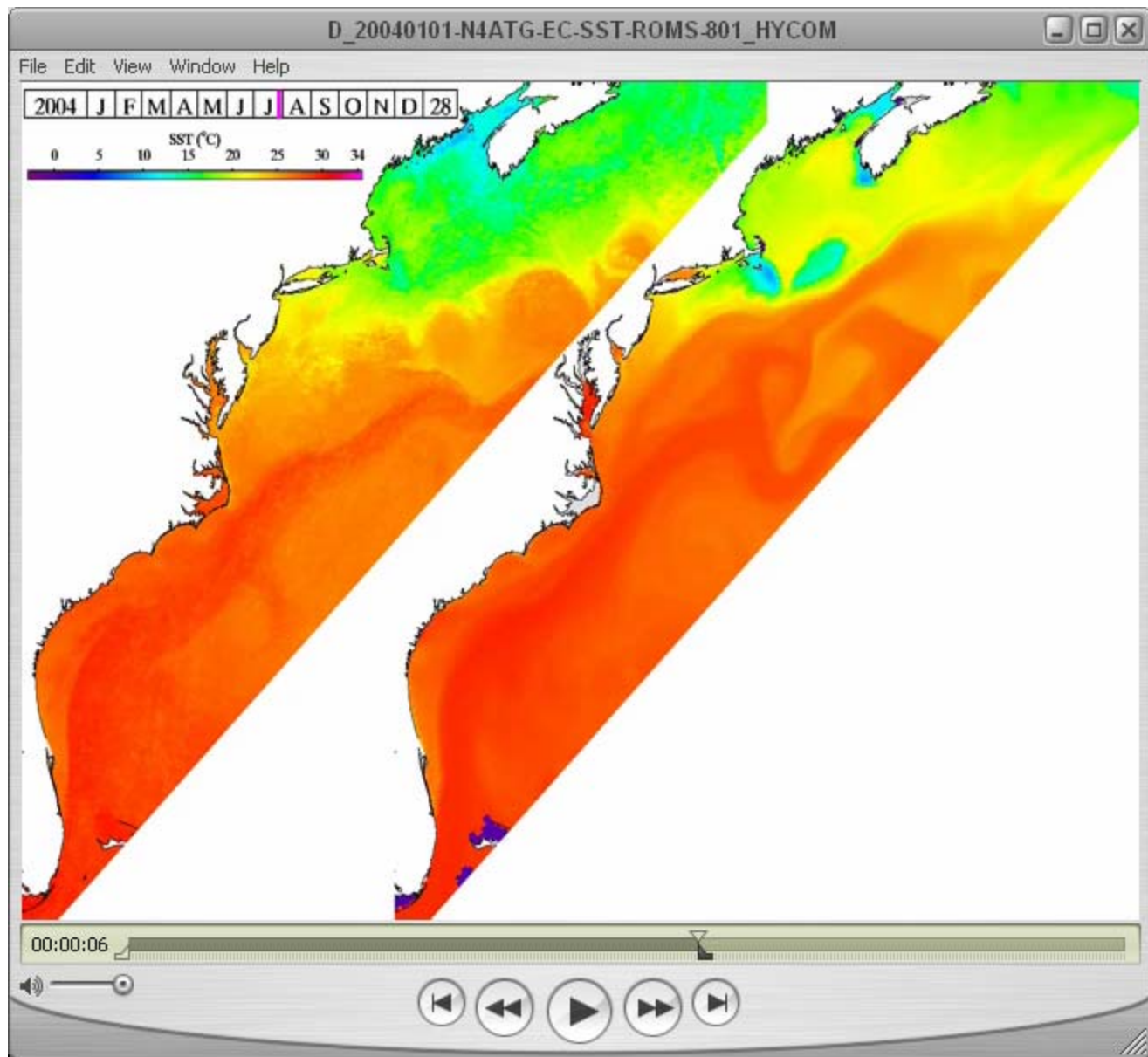


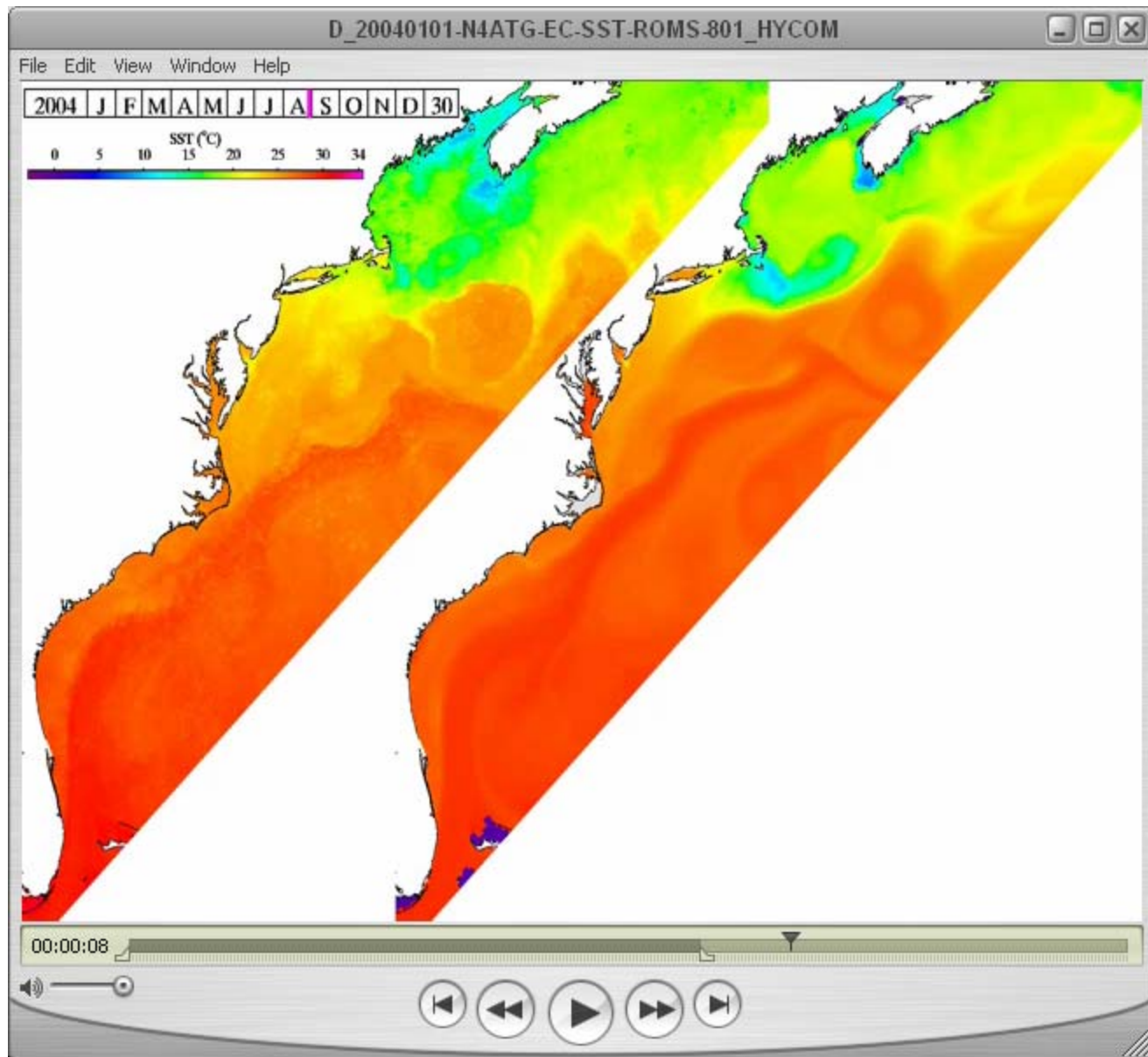


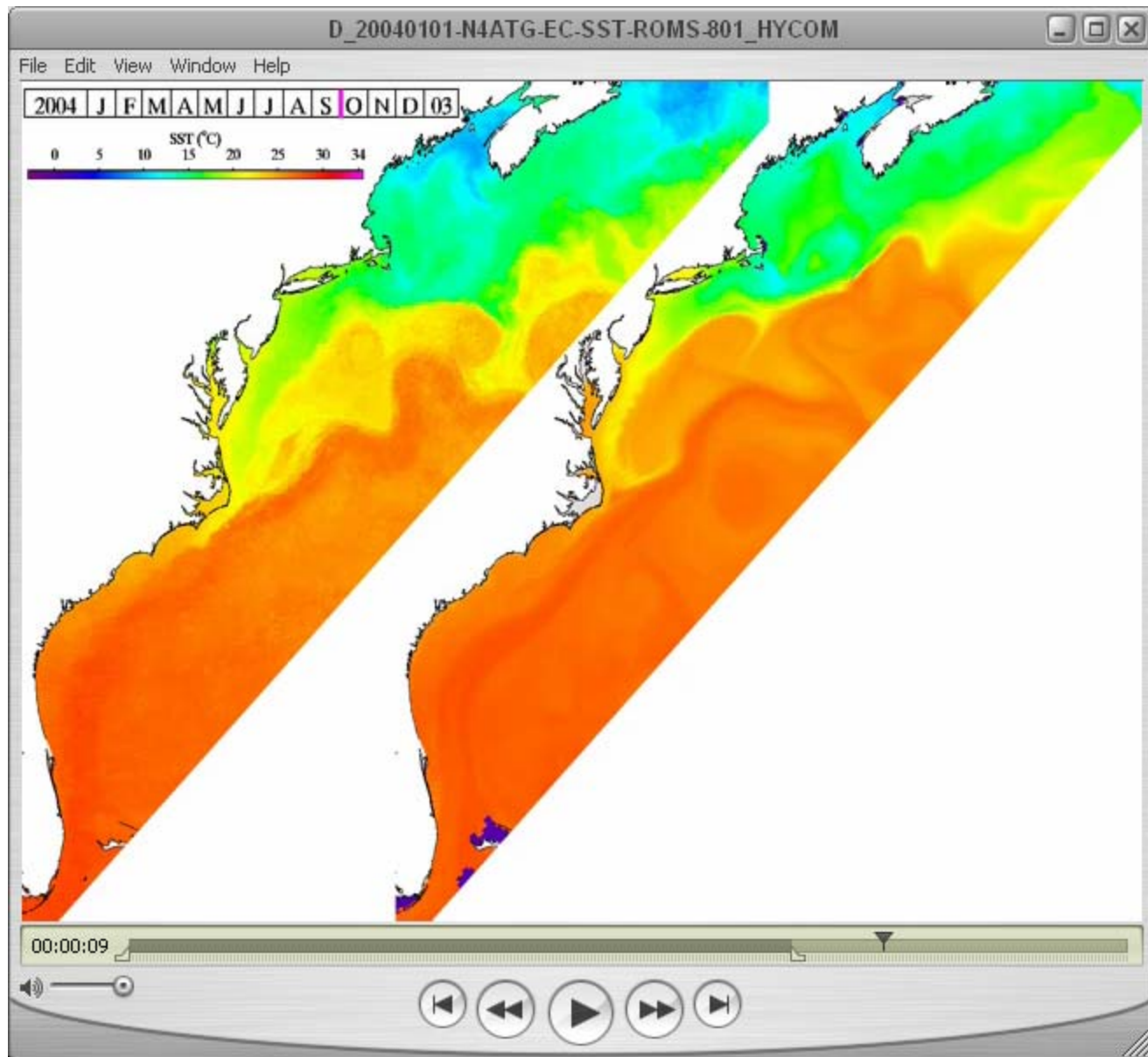


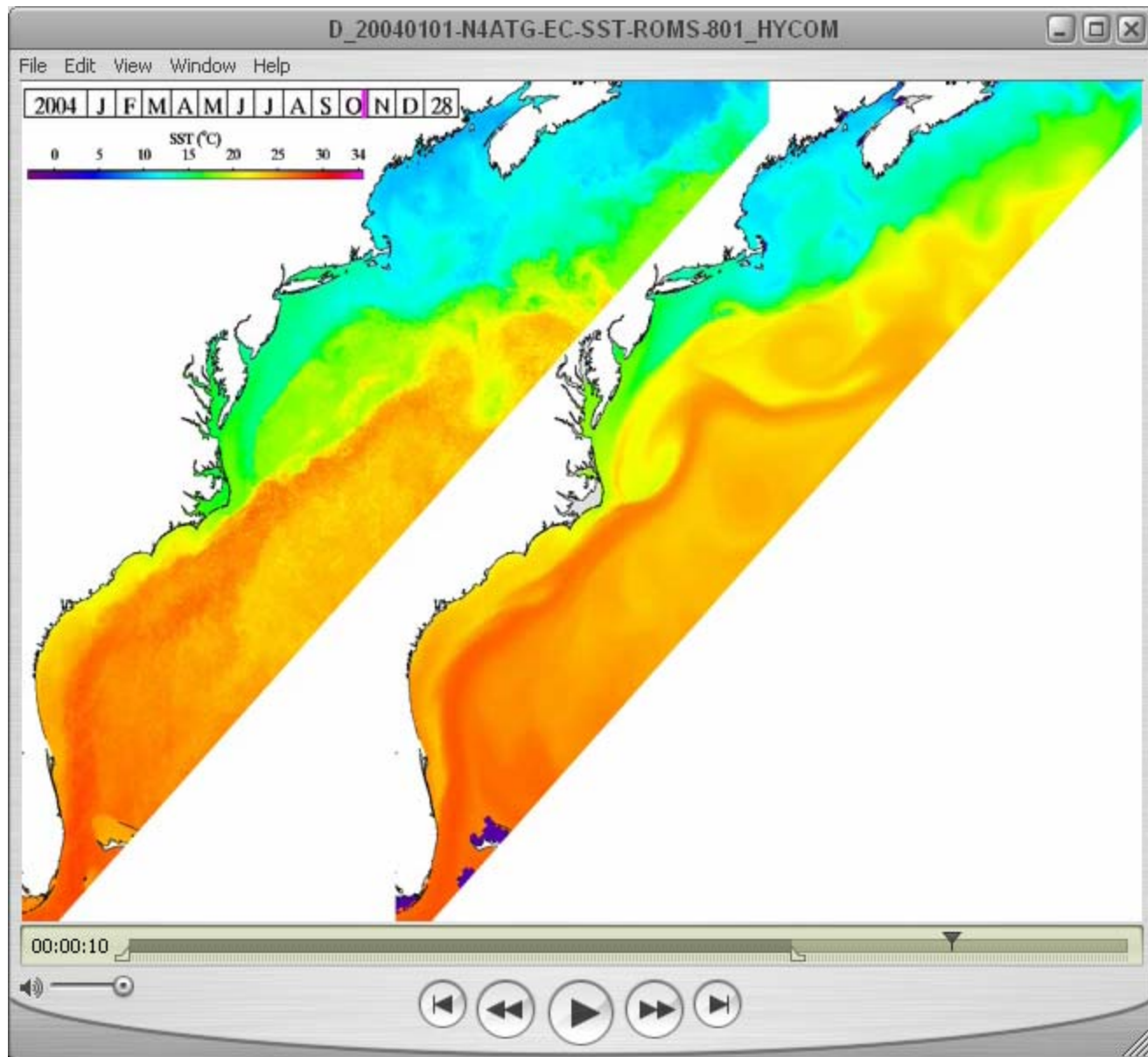


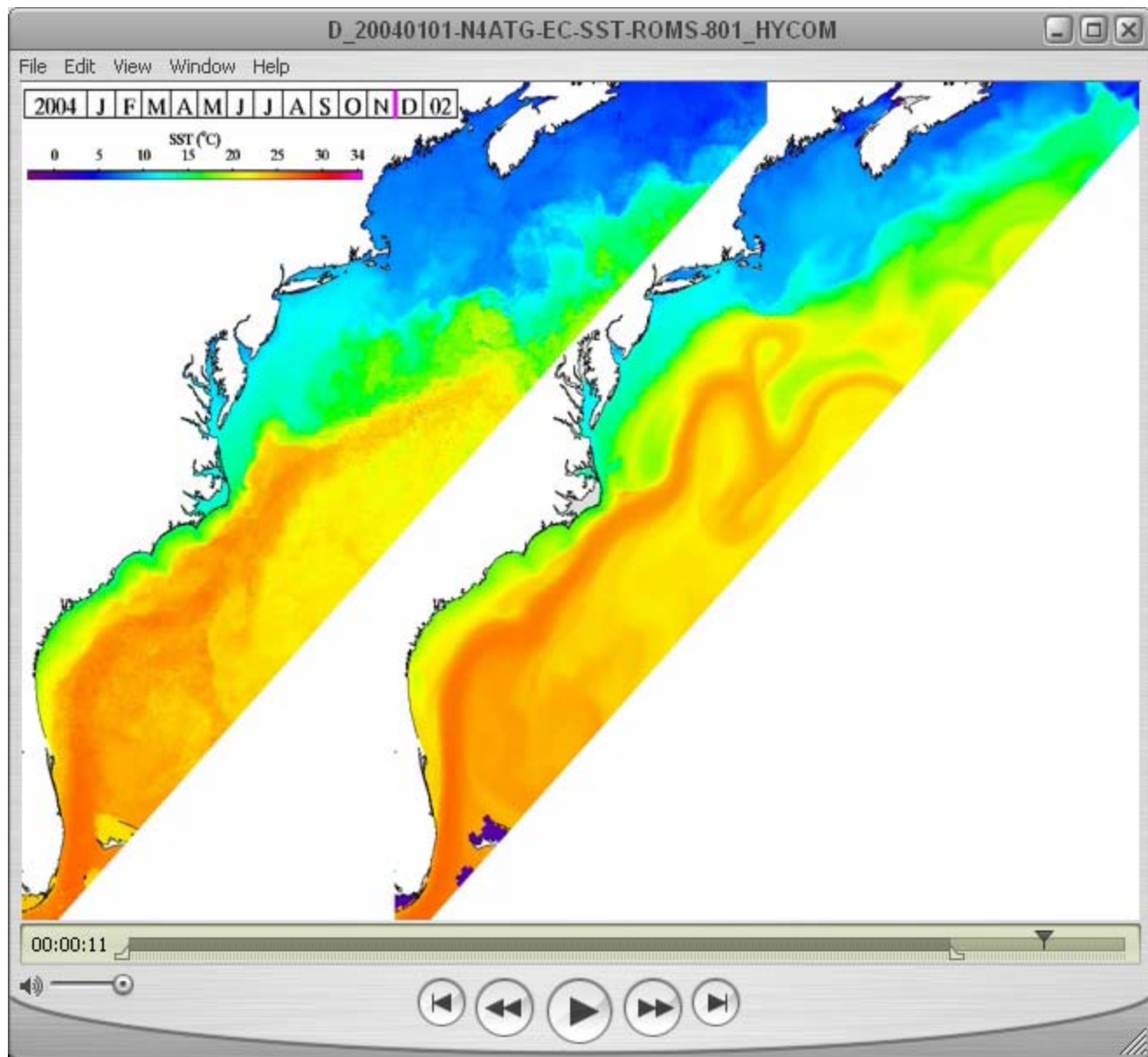


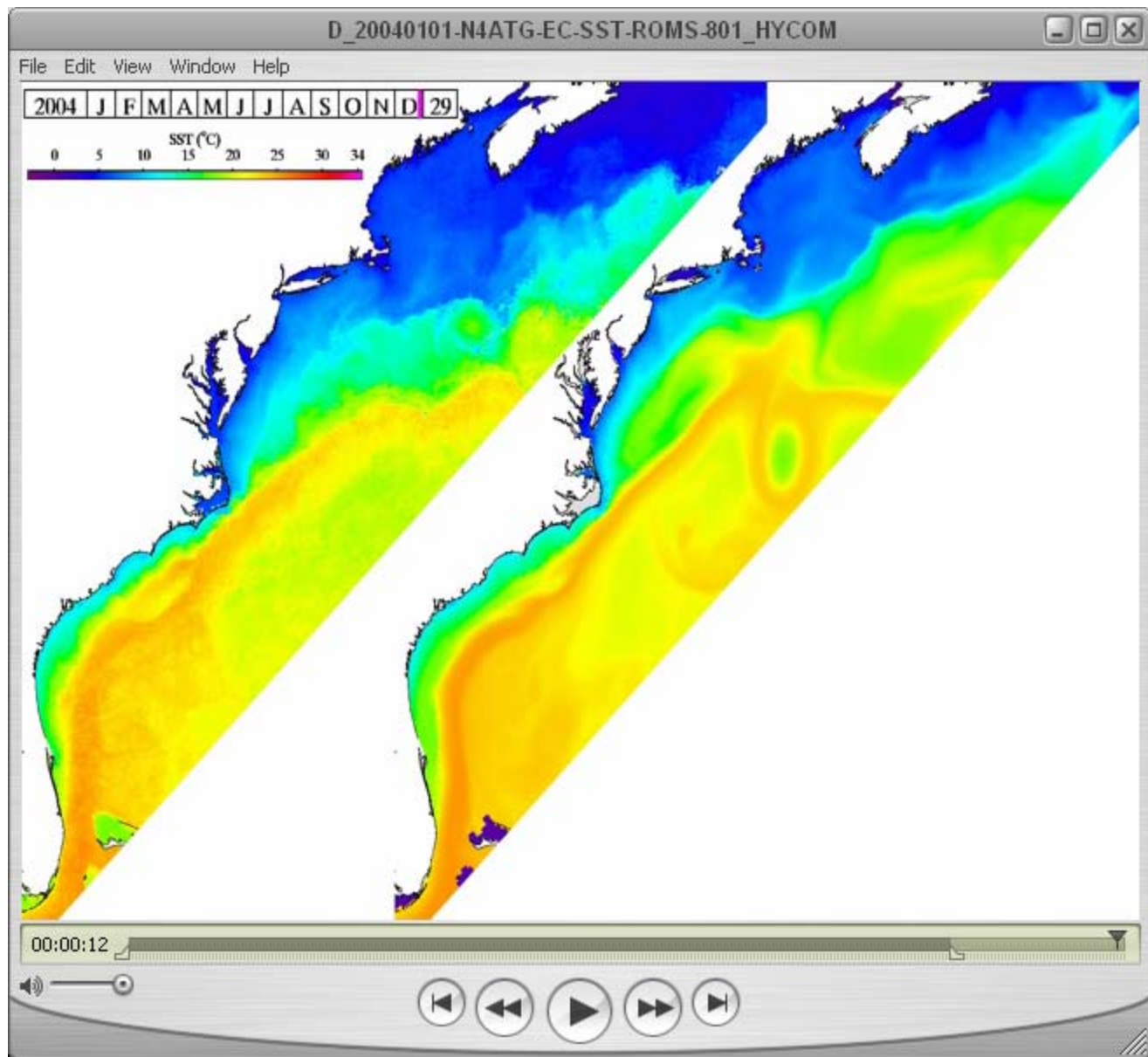


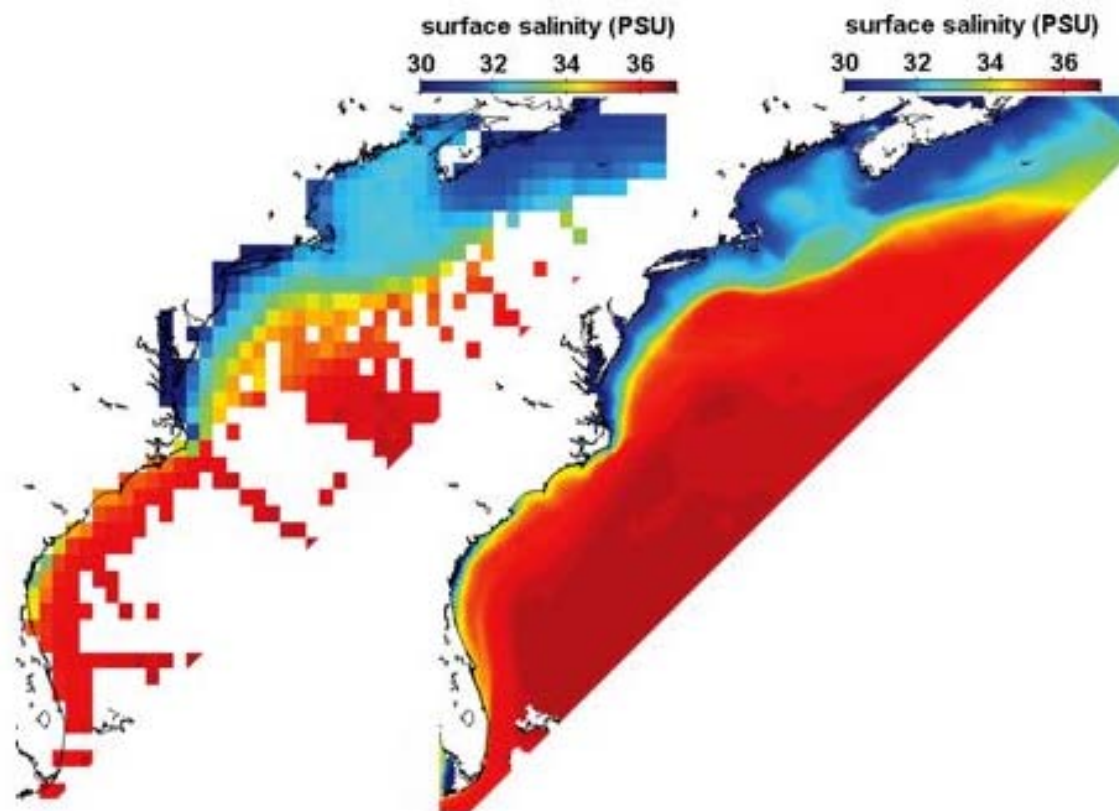


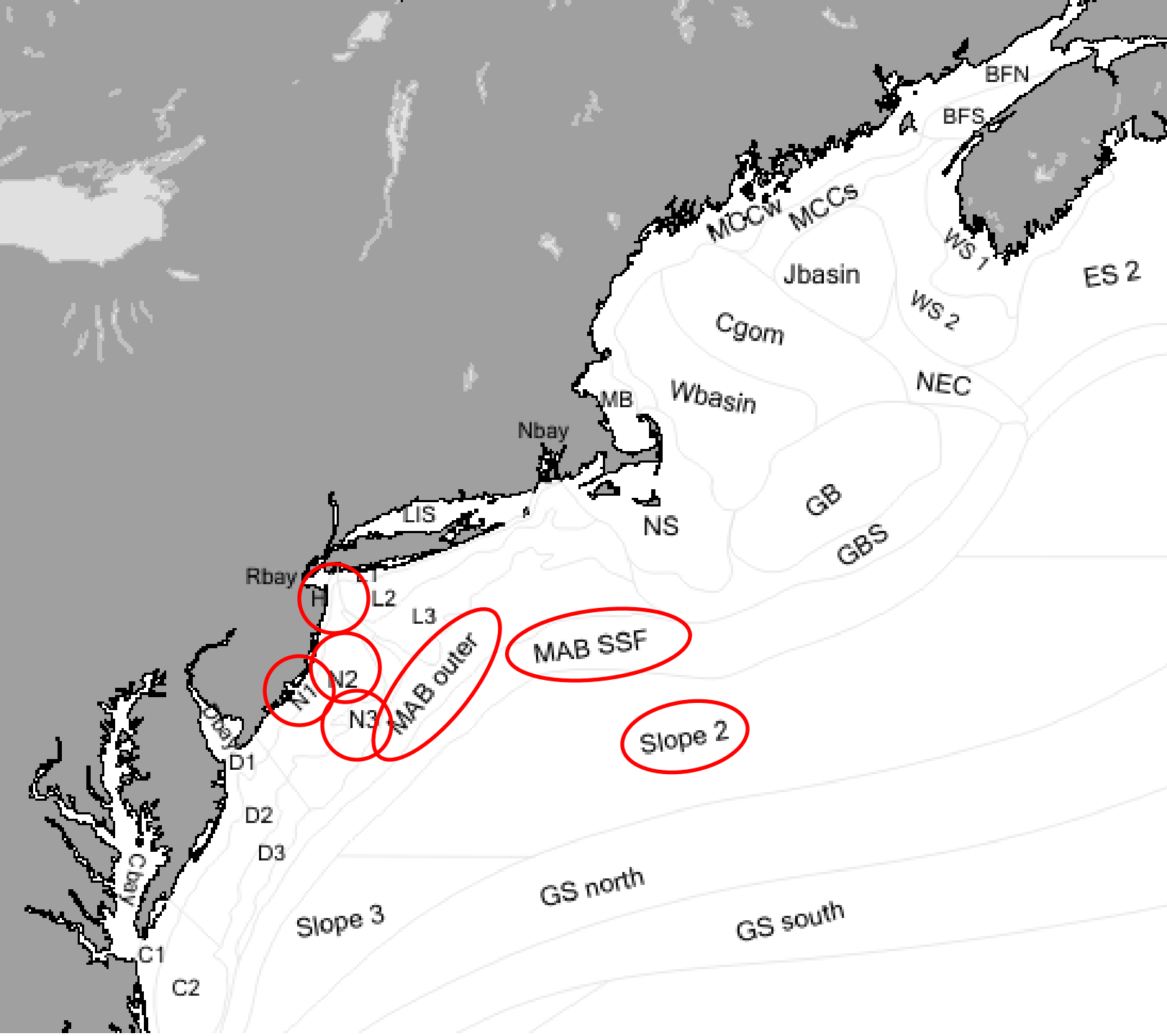




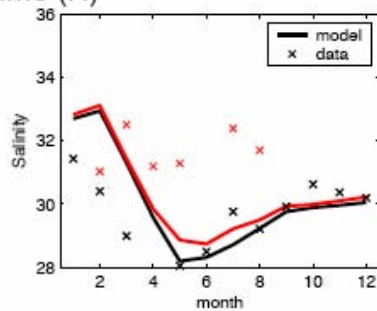
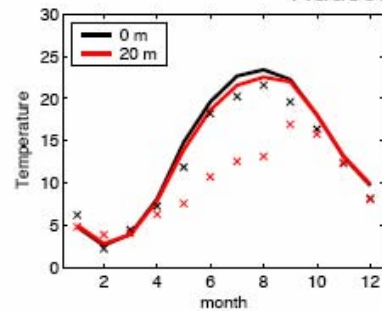




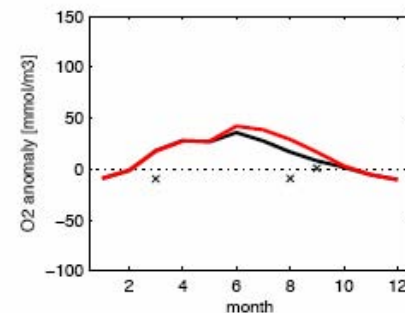
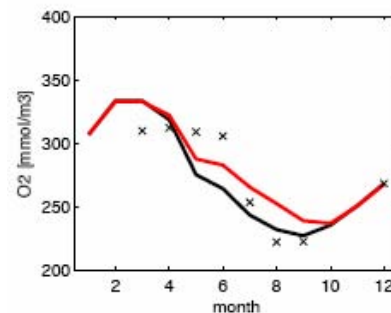
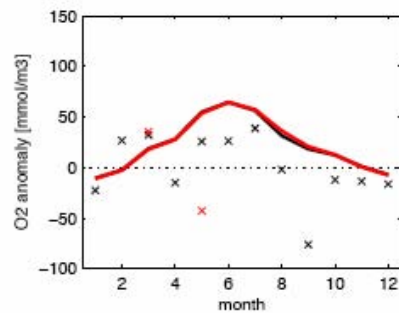
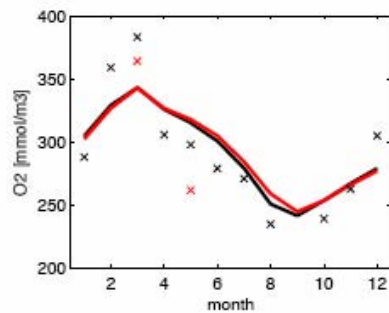
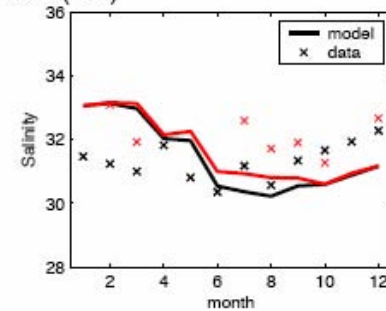
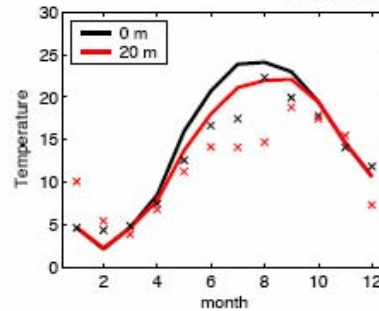




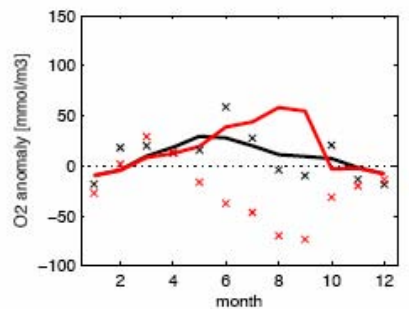
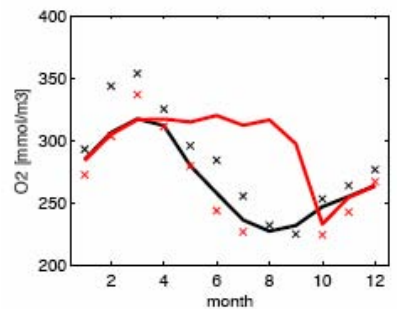
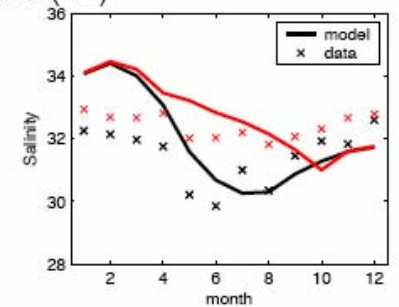
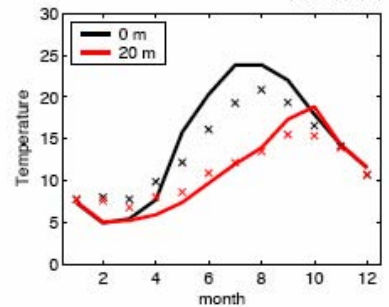
Hudson Plume (H)



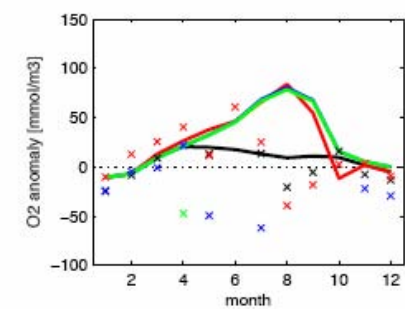
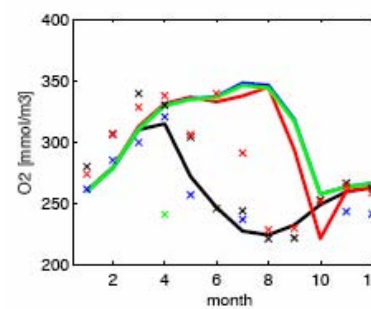
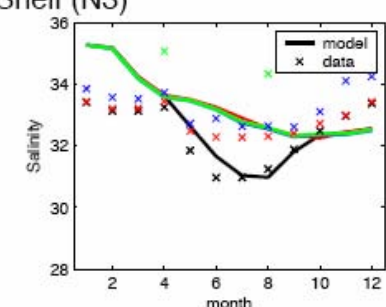
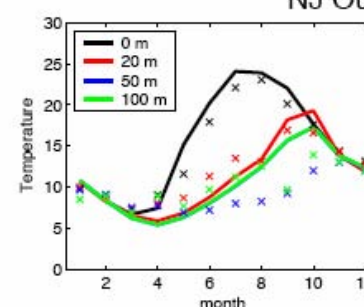
NJ Inner Shelf (N1)



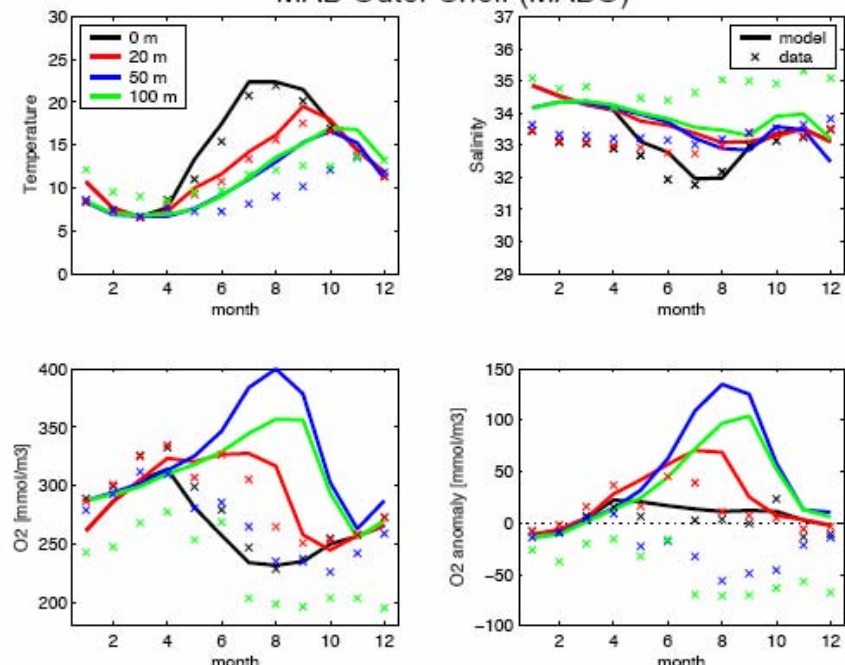
NJ Mid-Shelf (N2)



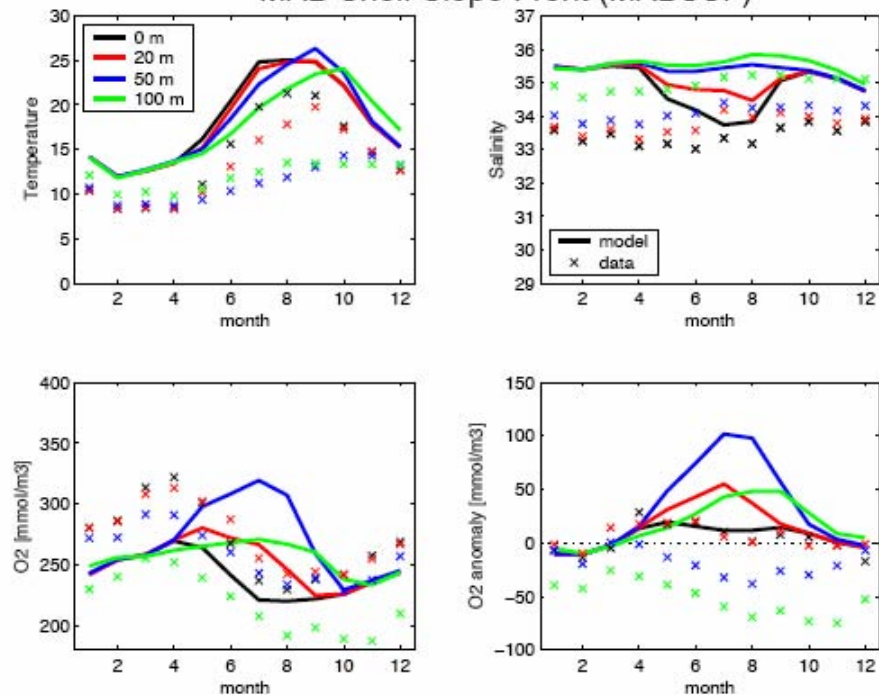
NJ Outer Shelf (N3)



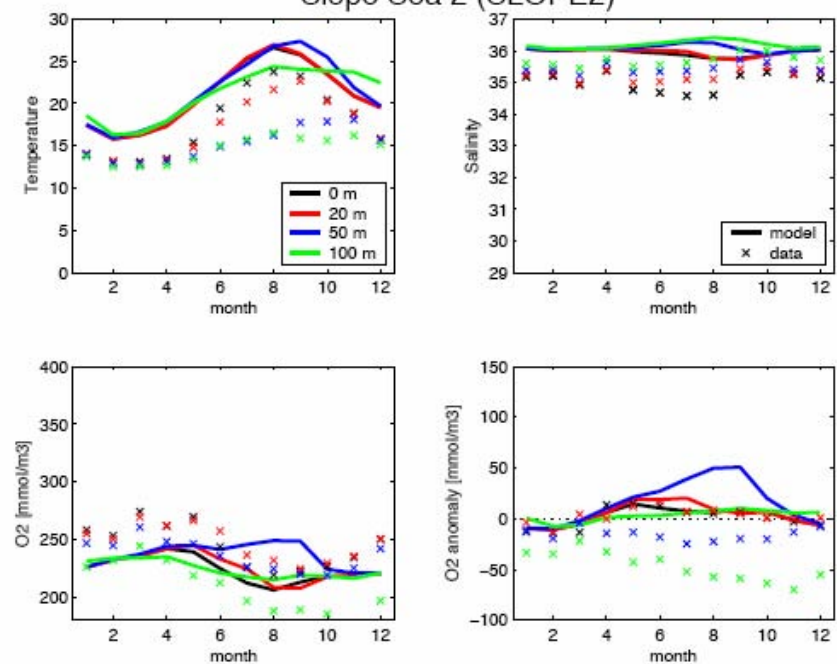
MAB Outer Shelf (MABO)



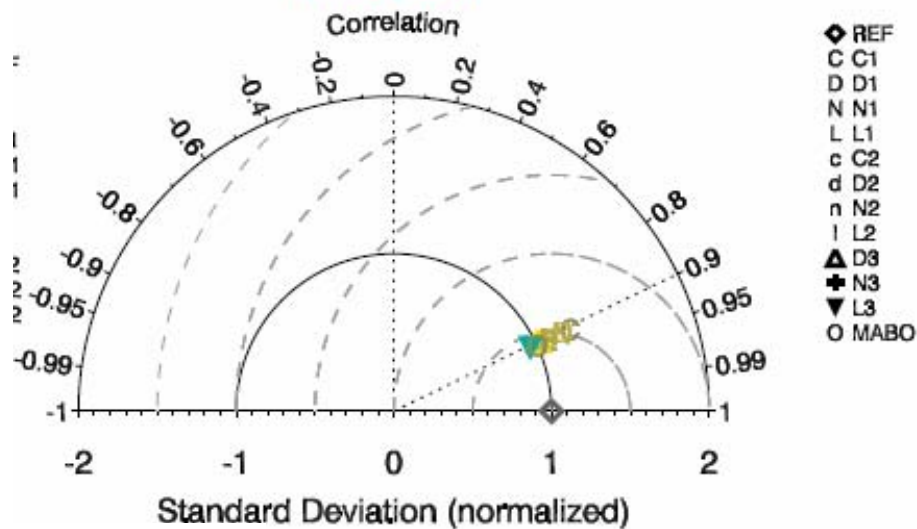
MAB Shelf Slope Front (MABSSF)



Slope Sea 2 (SLOPE2)

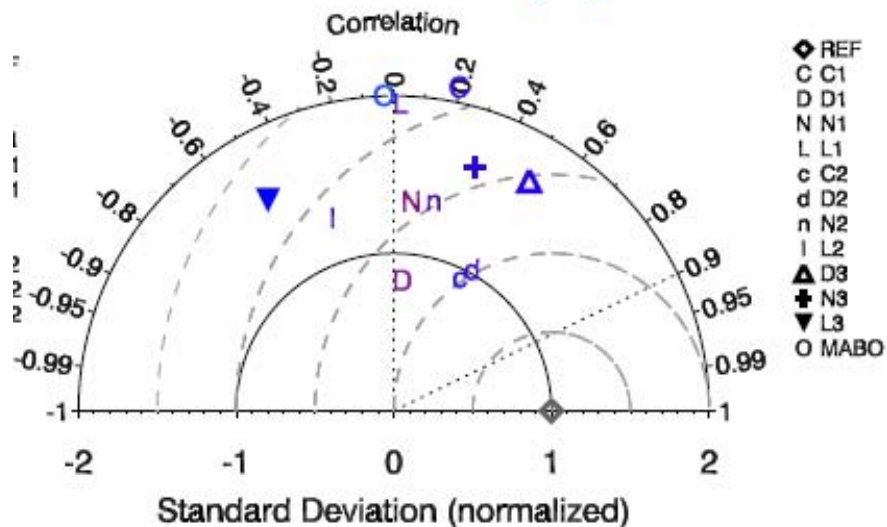


MAB SST

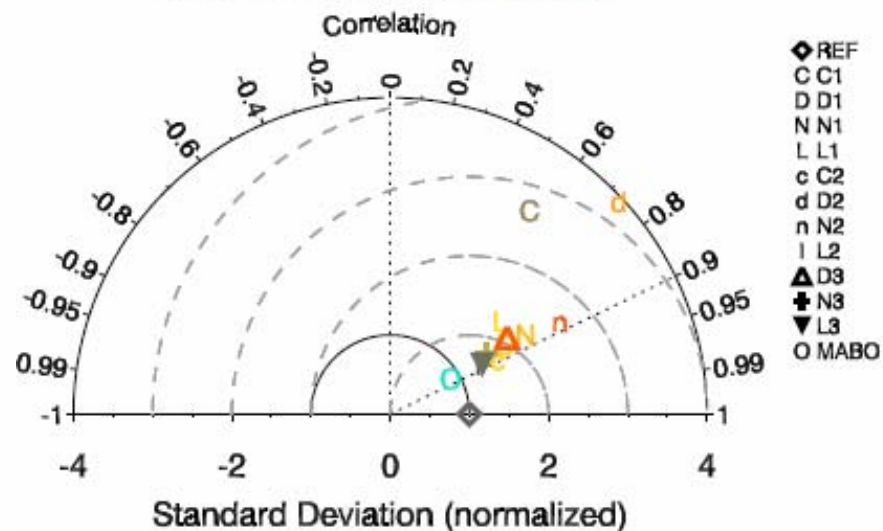


Taylor diagrams for model skill assessment

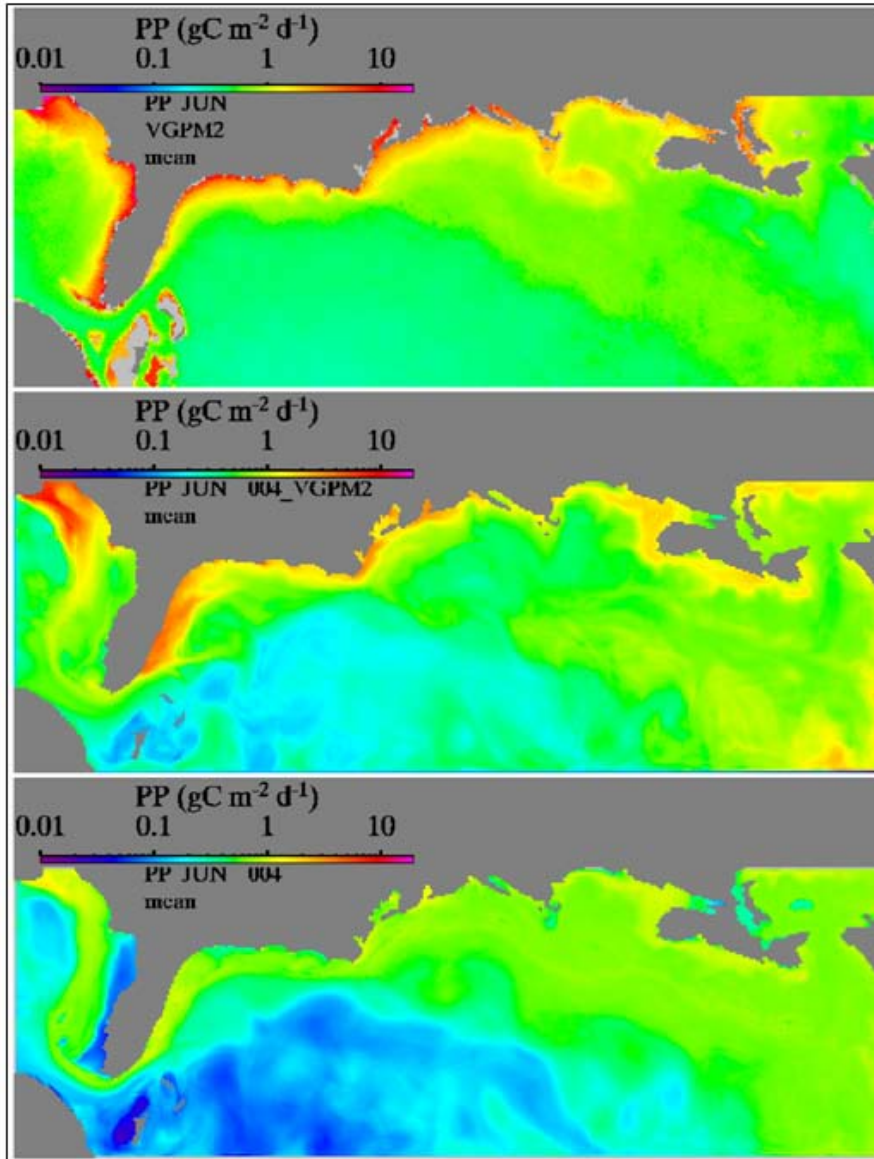
MAB Surface Chlorophyll



MAB Mixed Layer Depth



Model, satellite and ecosystem algorithm comparison



Satellite-derived
primary production (PP)
using VGPM2

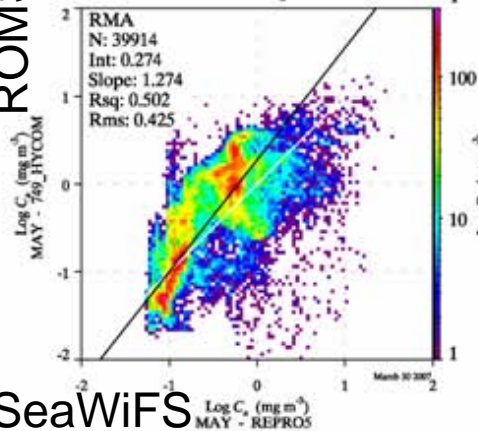
VGPM2 applied to
NENA-simulated fields

Modeled PP
using NENA

ROMS

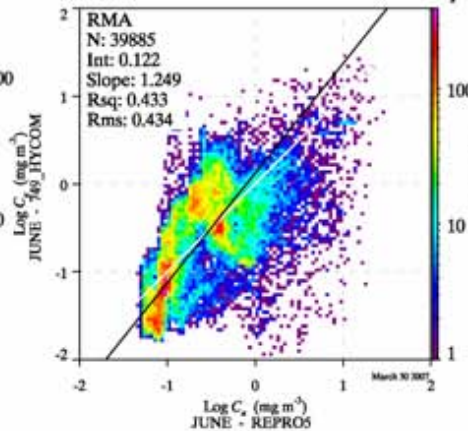
May

Freq.



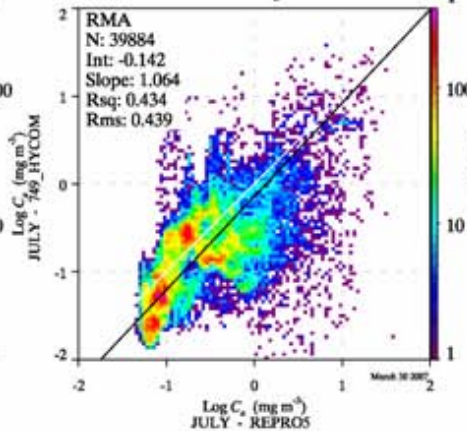
June

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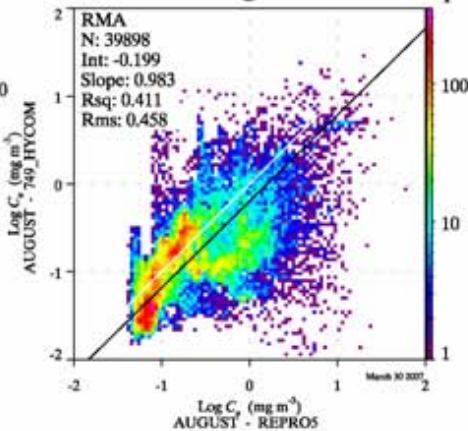
July

Freq.

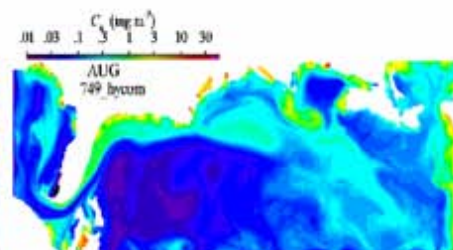
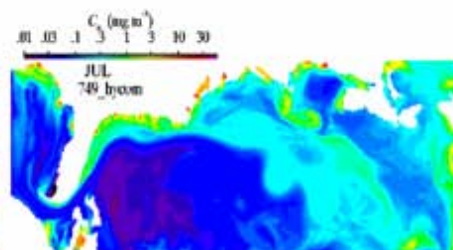
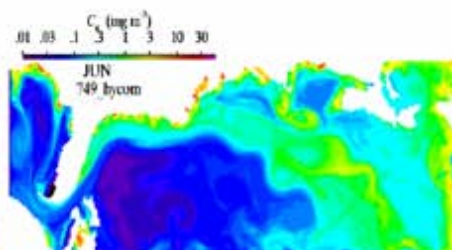
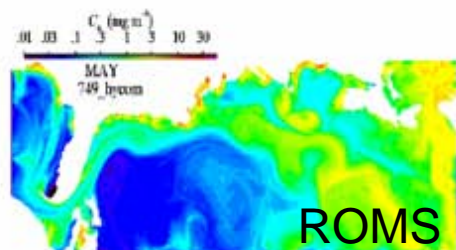
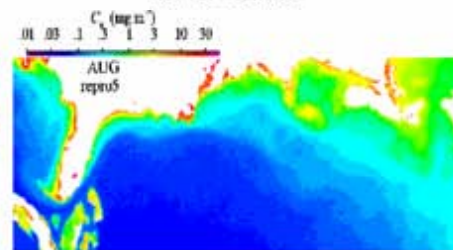
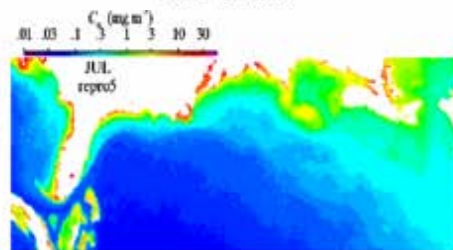
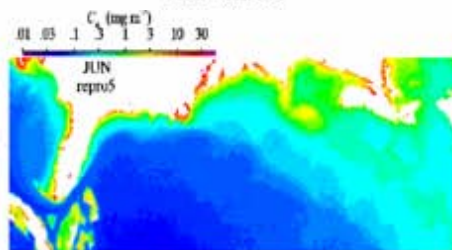
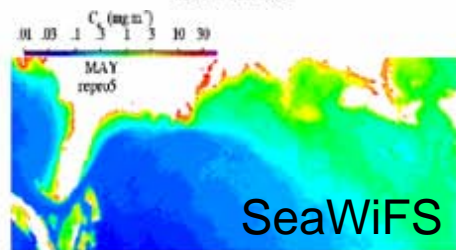


August

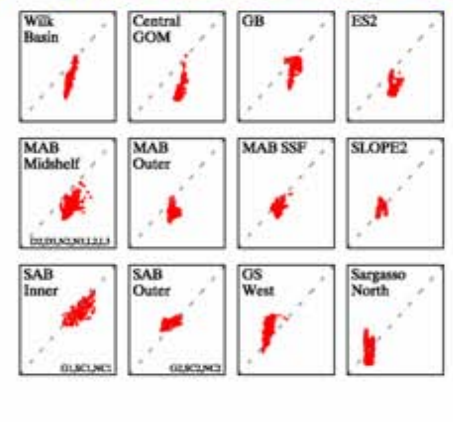
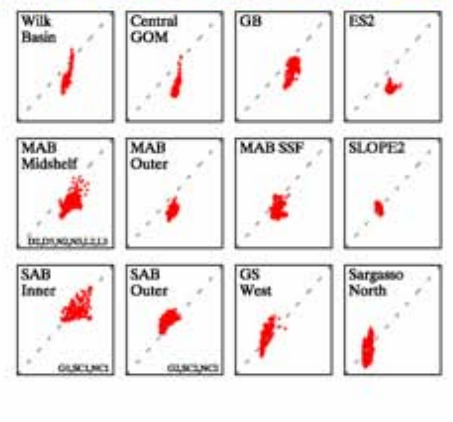
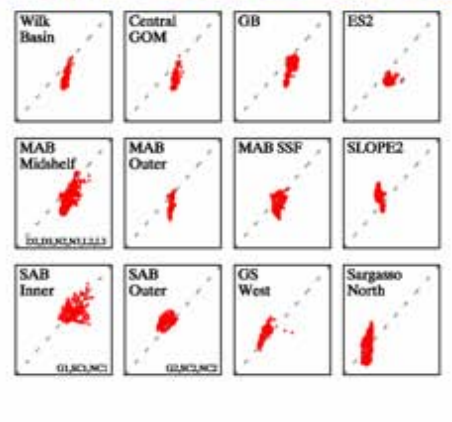
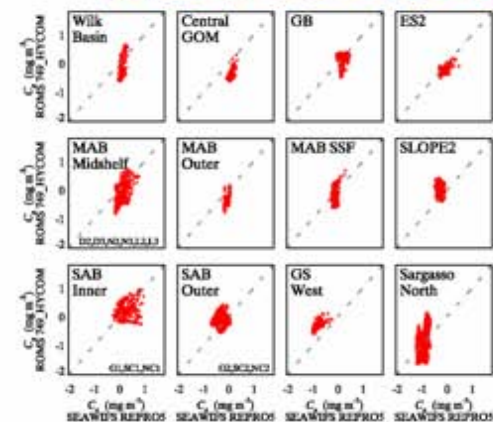
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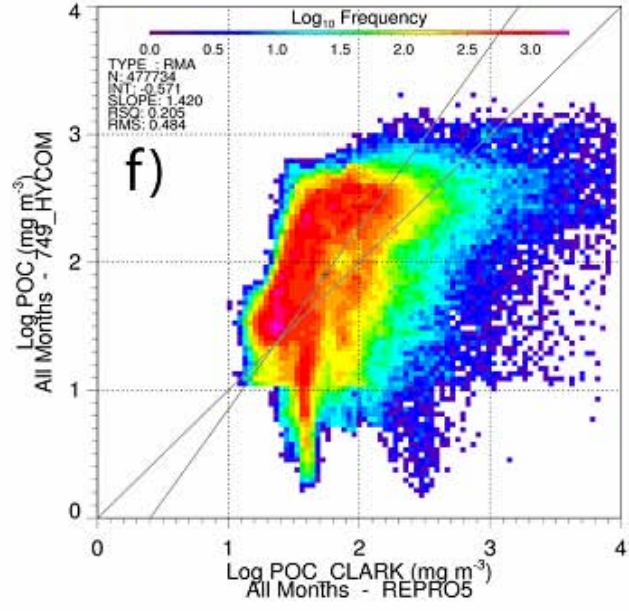
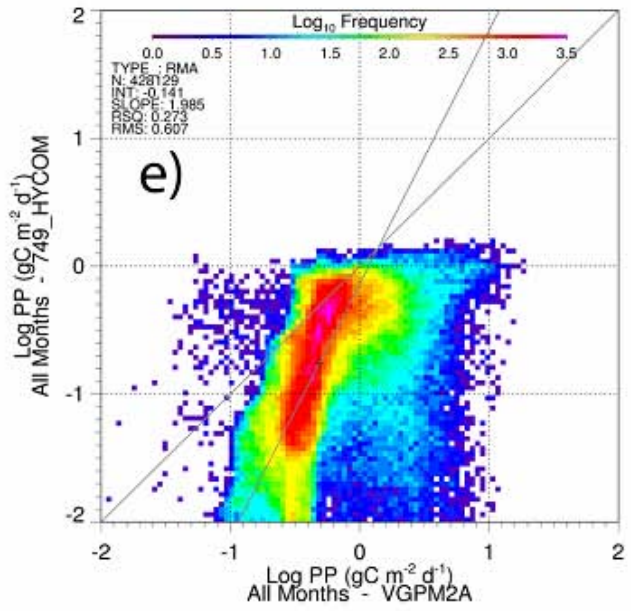
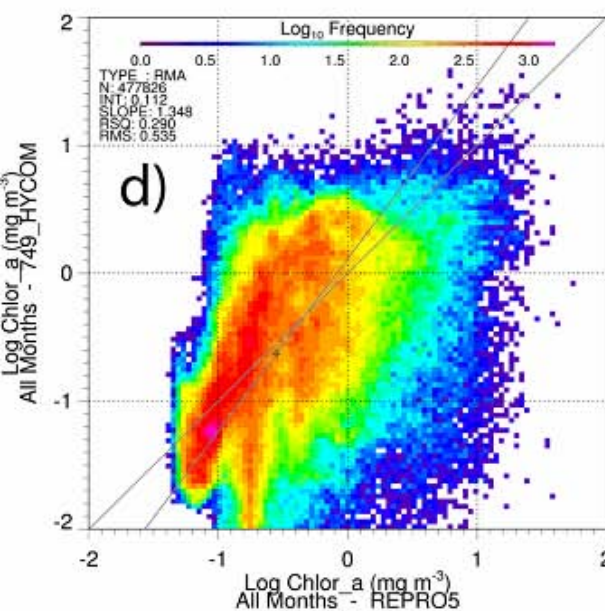
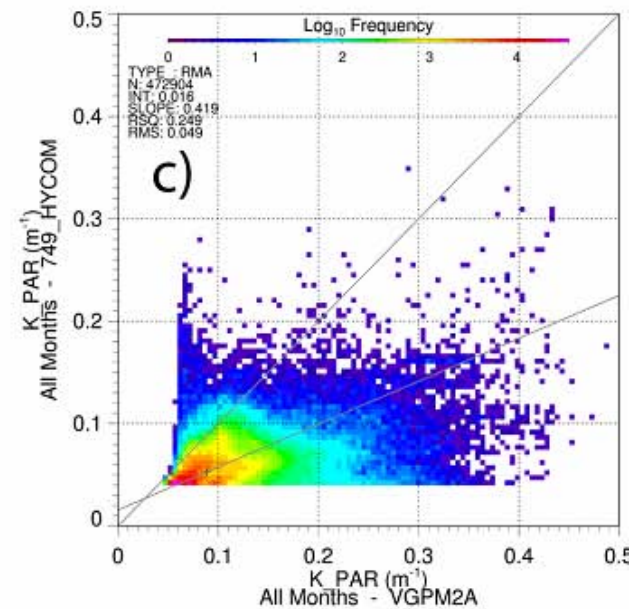
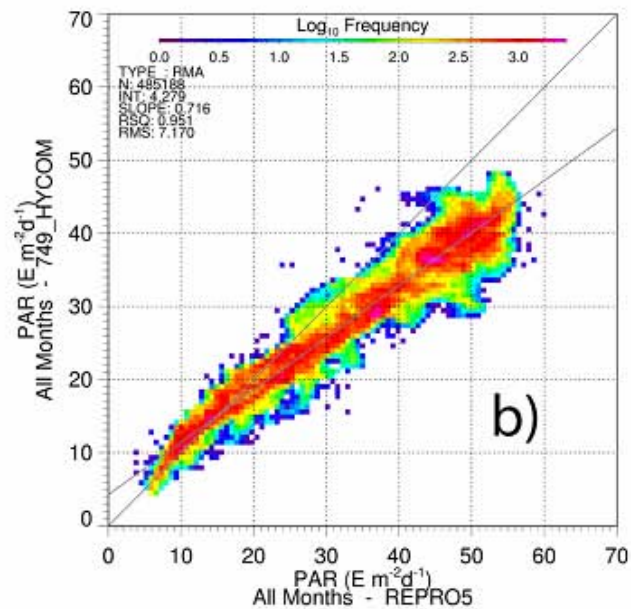
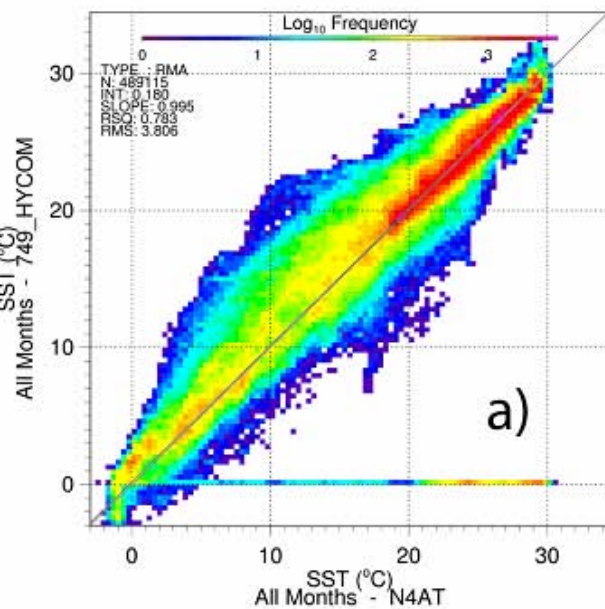


SeaWiFS

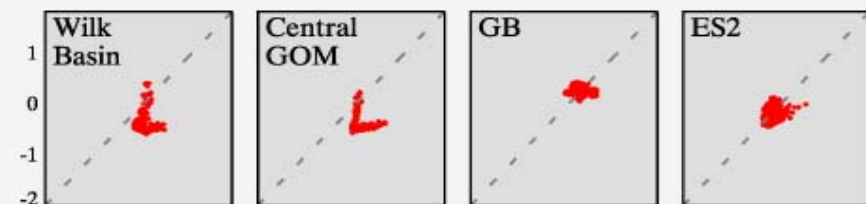
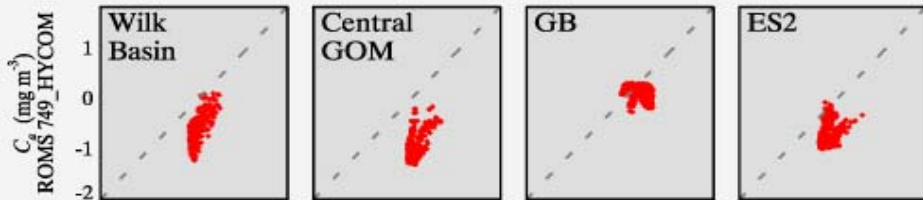
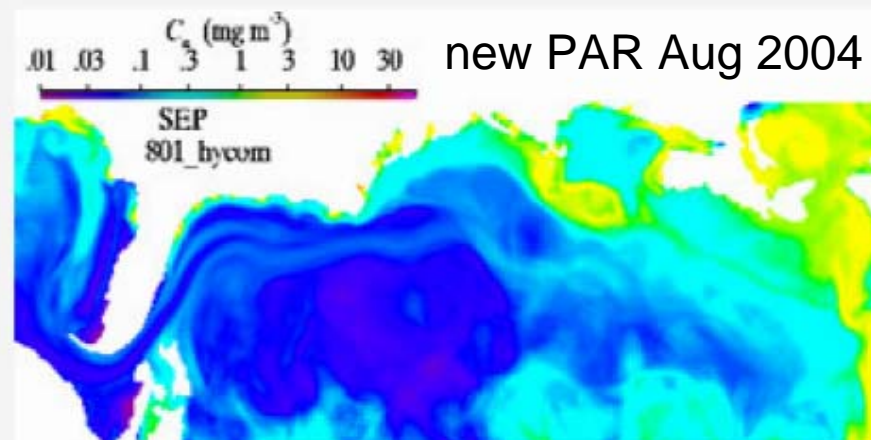
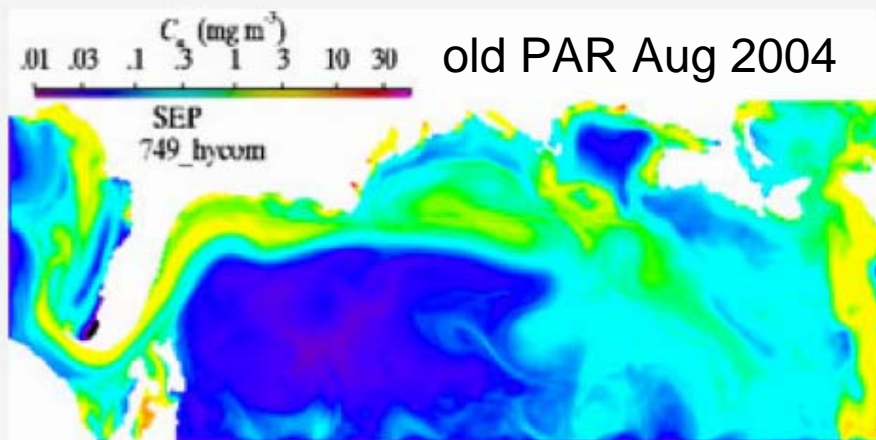
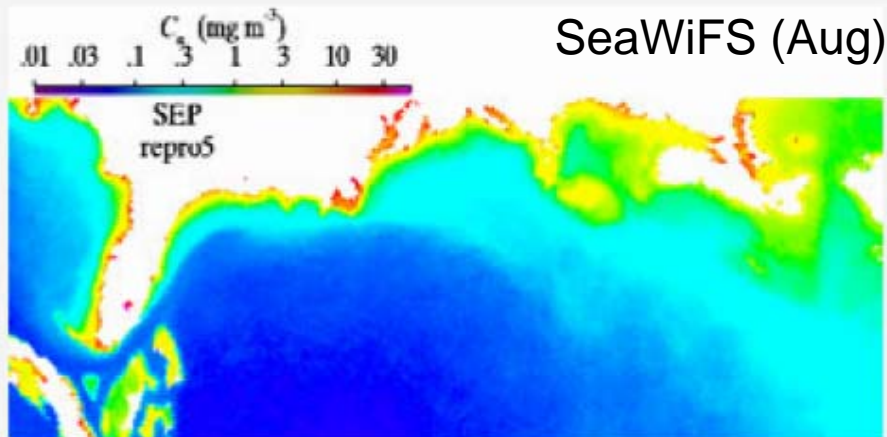
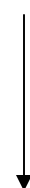


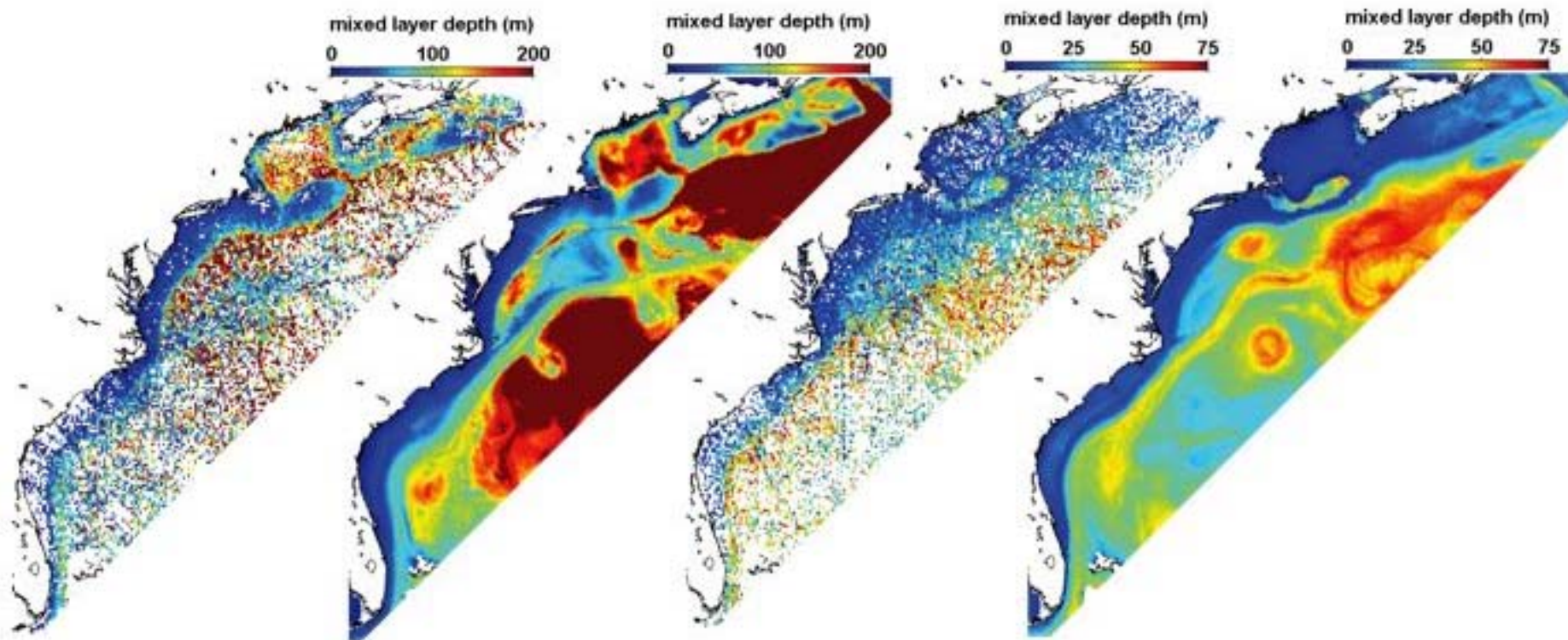
ROMS





Shallower euphotic depth gives more realistic chlorophyll distribution on Georges Bank, the Gulf of Maine and the Slope Sea.



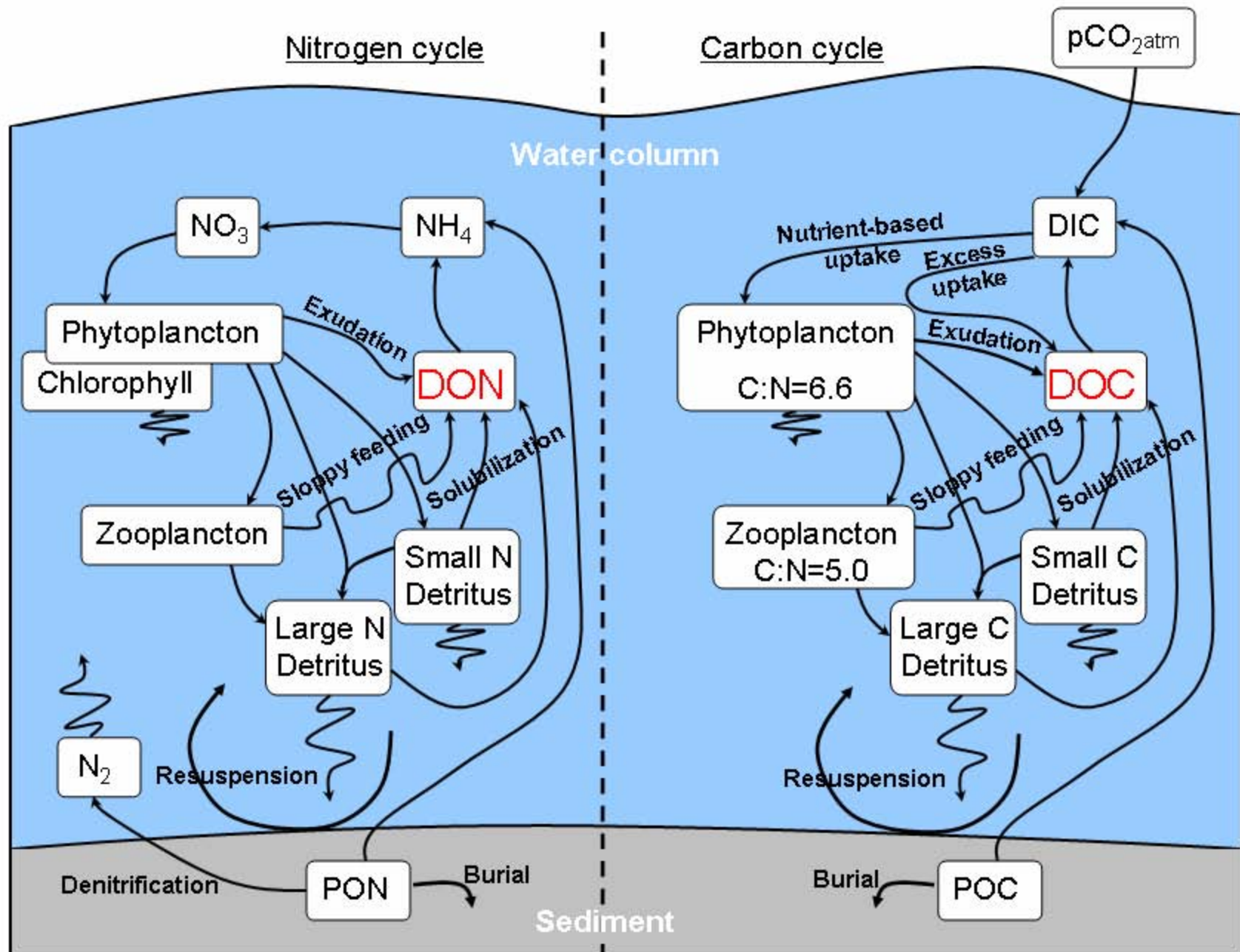


March
climatology

March
model

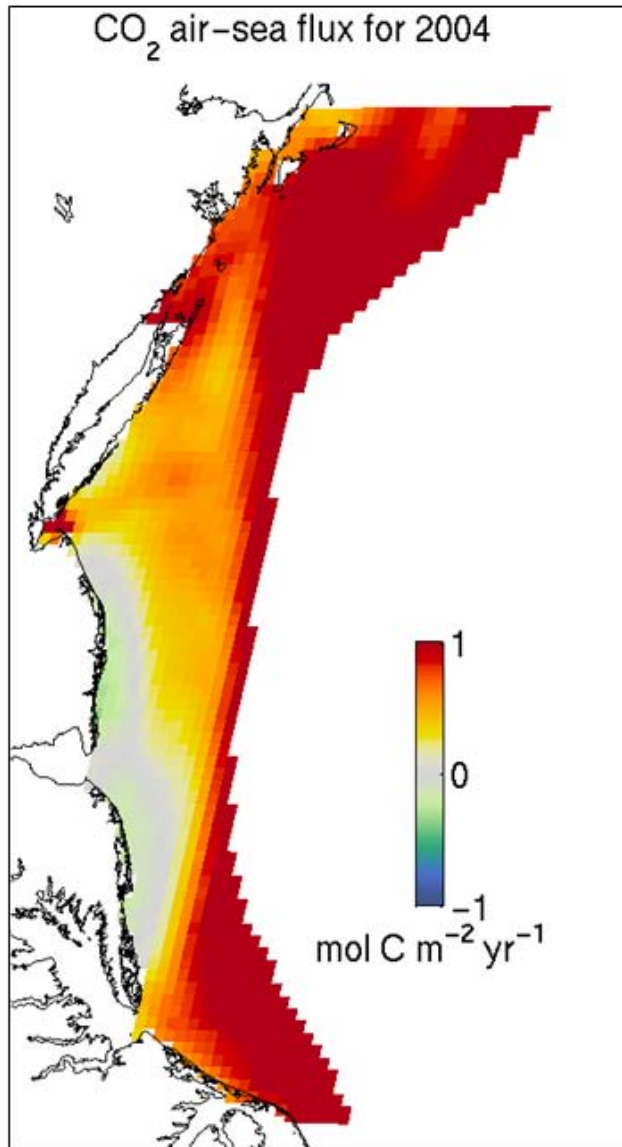
September
climatology

September
model



Semilabile DON and DOC with degradation rates from weeks to months

Continental shelf carbon cycle



Simulated annual air-sea flux of CO₂
Explicit inorganic carbon cycling

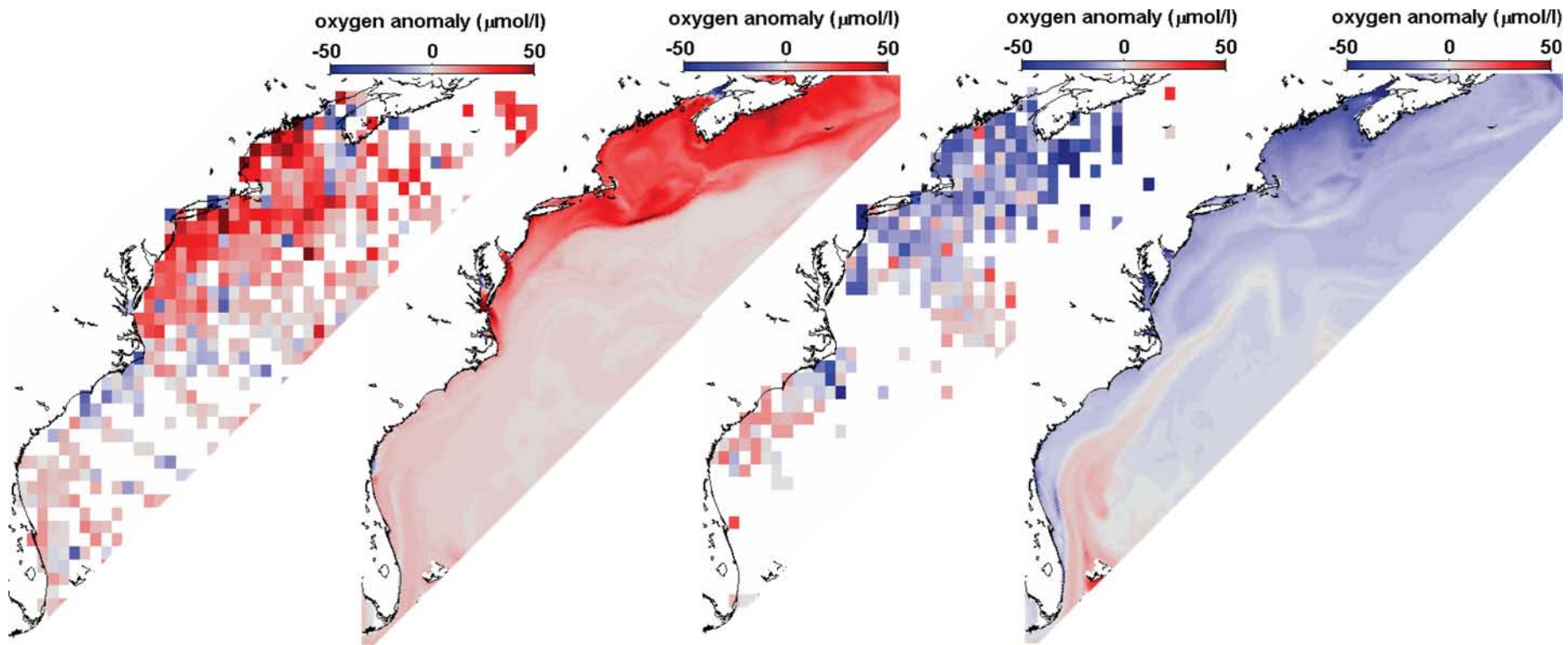
Positive values indicate uptake by ocean

Outer Mid-Atlantic Bight continental shelf is a sink for atmospheric CO₂

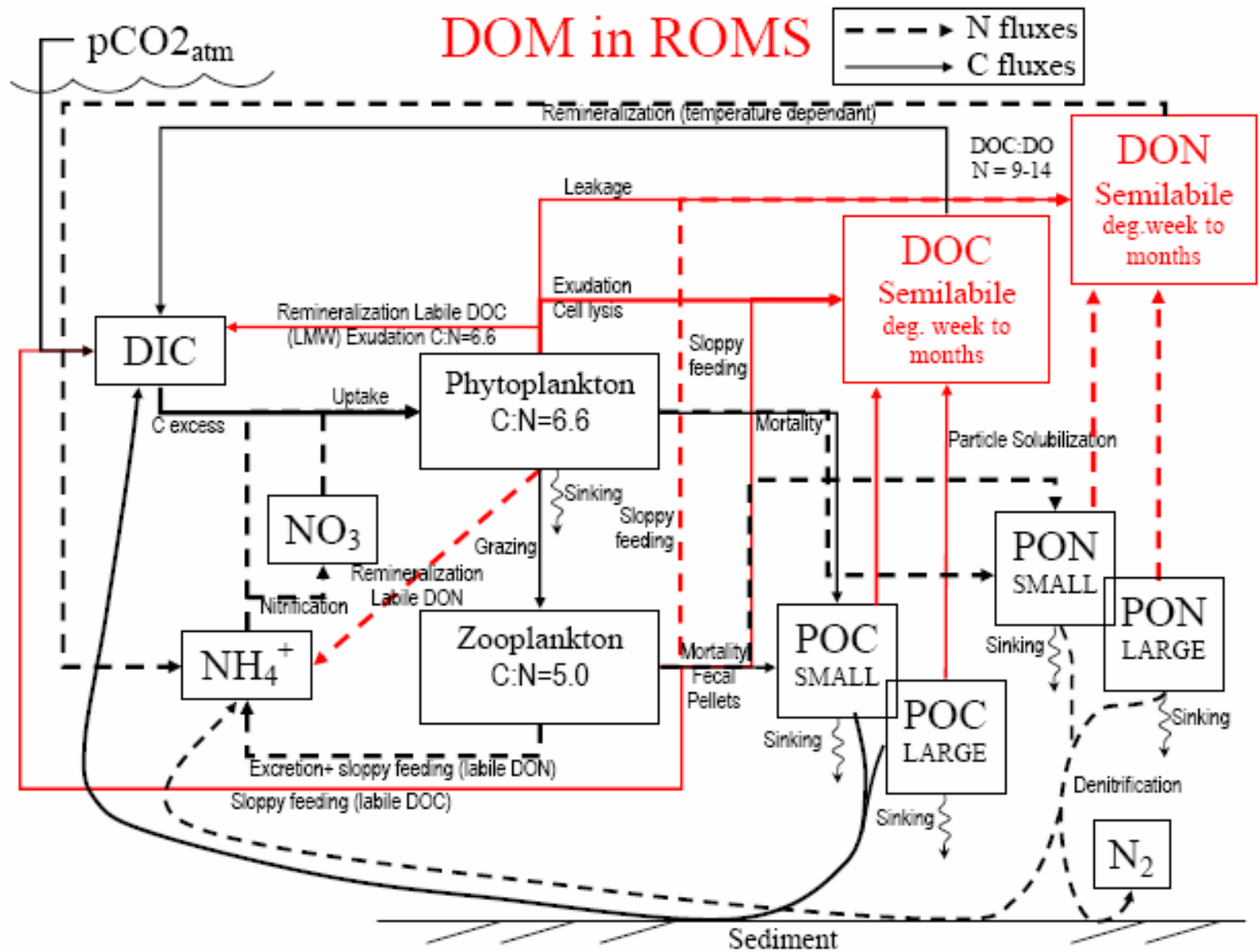
No net uptake off NJ due to outgassing during summer from upwelling

MAB atmospheric CO₂ uptake estimates

	DeGrandpre <i>et al.</i> (2002)	Model	Model w/o DNF
Total (Mt C yr ⁻¹)	1.0 ± 0.6	0.9	1.62
Inner Shelf (0-20 m) (mol C m ⁻² yr ⁻¹)	0.9 ± 0.63	0.38	1.1
Mid-shelf (20-50 m) (mol C m ⁻² yr ⁻¹)	1.6 ± 1.28	0.57	1.2
Outer Shelf (50-200 m) (mol C m ⁻² yr ⁻¹)	0.7 ± 0.07	0.91	1.2

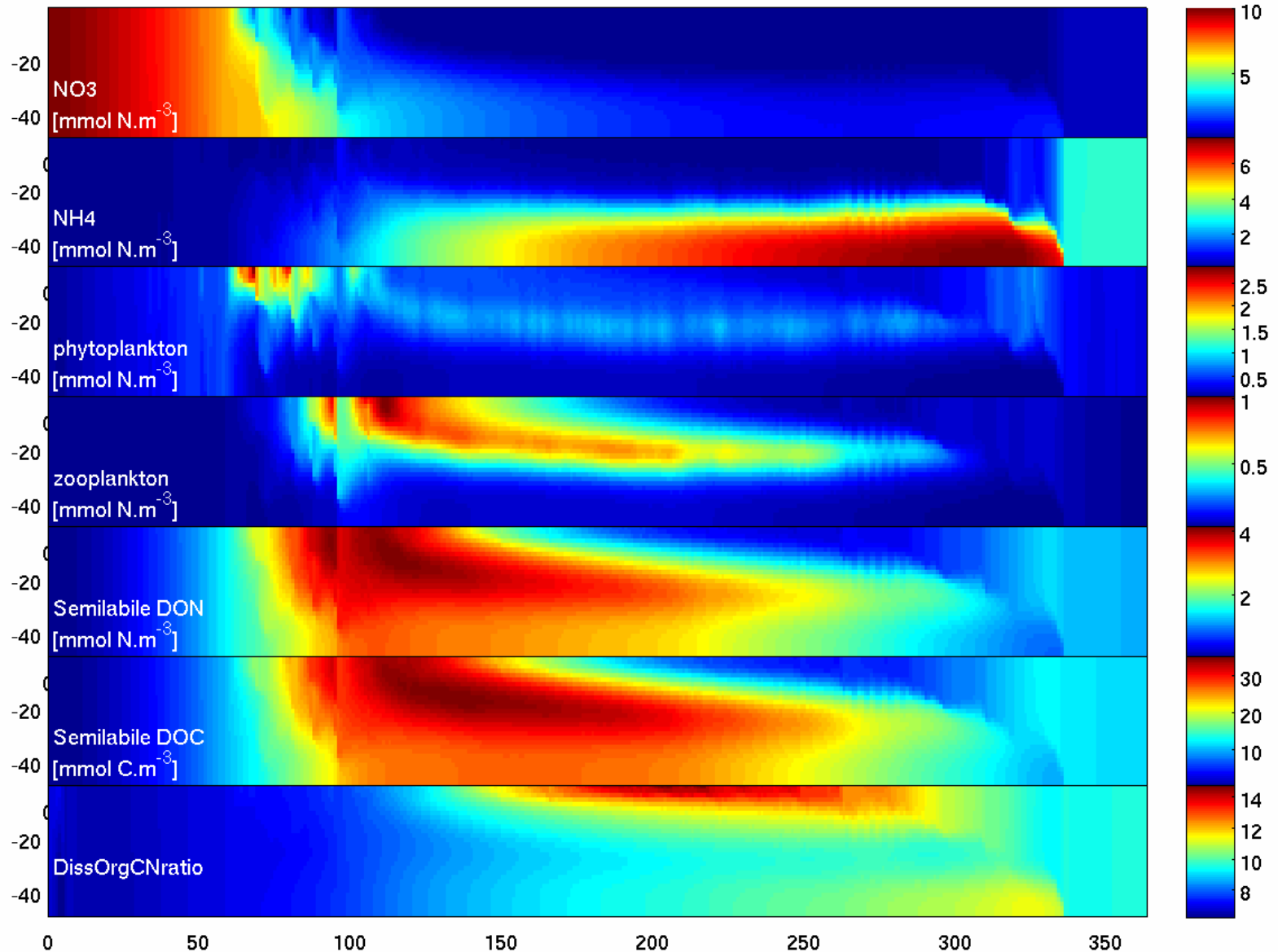


DOM modeling



1-D Mid Atlantic Bight results

/home/druonje/OUTPUT/ROMS/src2/biotoy_his_fashC_frc_ij_112_205_2004.nc



Summary: Status/Future

- ROMS-in-HYCOM for NENA works
 - but requires that the salinity bias is corrected
 - increasing resolution will not solve bias
 - ROMS biases:
 - South Atlantic Bight bottom temperatures too cold
 - shelf stratification too strong
 - MAB shelf/slope front under-resolved
 - ROMS/BGC:
 - sensitivity to vertical mixing, k_{PAR} being pursued
 - must consider benthic processes (semi-labile constituents, diagenesis, denitrification, export, benthic primary productivity)
 - DOC model running now

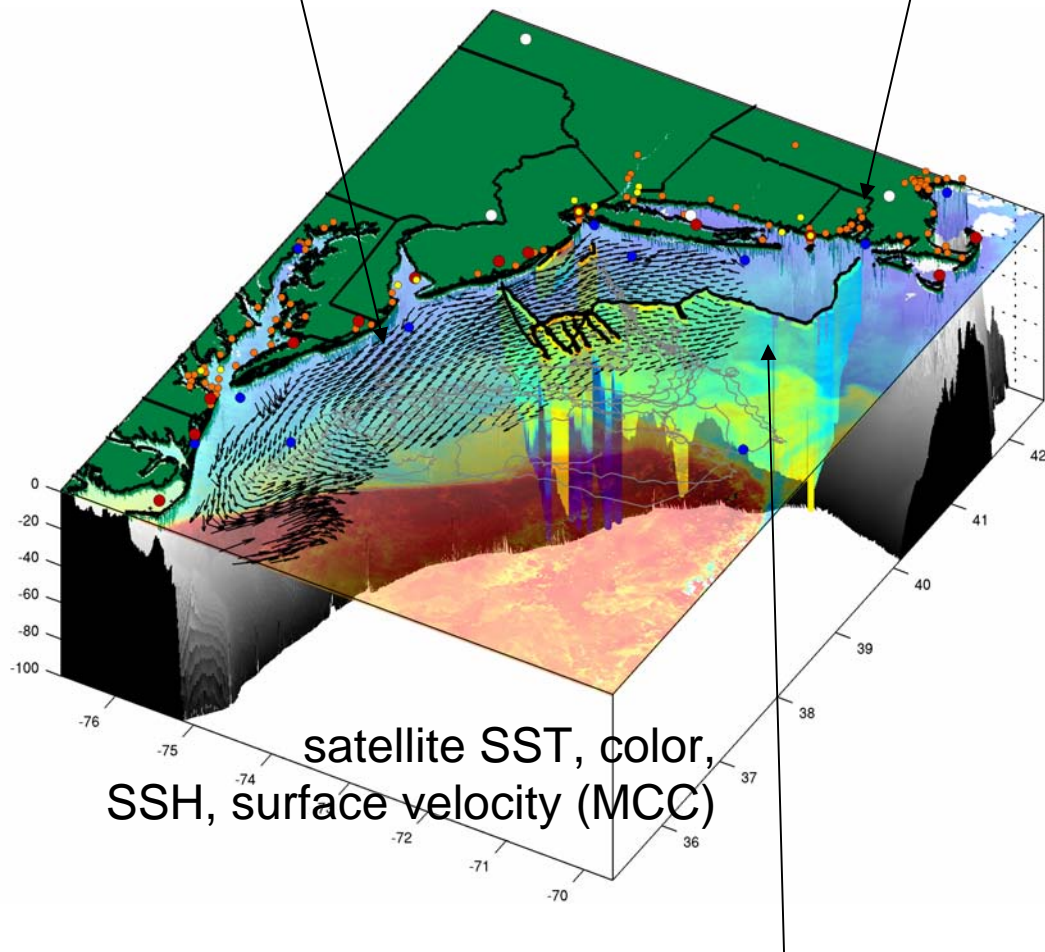
**Experimental System for Predicting Shelf and Slope Optics*

Summary: Status/Future

- Needs
 - explore improved open boundary condition schemes
 - better process for data transfer and coordinate remapping (presently ad hoc extrapolation and land/sea/bathy mis-match)
 - especially for future operational applications (MURI-ESPreSSO*) unbiased Hycom (on shelf) preferred
 - but possibly corrected via shelf assimilation
 - should use inter-annual river flow variability (in both models but especially in ROMS)
- Future
 - Operational MAB
 - 4DVar assimilation of Coastal Observing System data
 - gliders, CODAR, cabled observatory
 - Optics model for ESPreSSO
 - multiple nesting within ROMS

**Experimental System for Predicting Shelf and Slope Optics*

CODAR surface currents
coastal meteorology



satellite SST, color,
SSH, surface velocity (MCC)

glider: T,S, optics along paths

ROMS in HYCOM

